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The professional papers contained in The Journal are published prior to the meetings at which they are to be presented, in order to afford members an opportunity to prepare any discussion which they may wish to present.

HISTORY OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Preliminary Report of the Committee on Society History

Chapter VII

WORLD'S FAIR PLANS AND THE CALIFORNIA TRIP

170 Mention has already been made of the presidential address of Mr. Henry R. Towne, and an extract from it describing the European trip of 1889 has been included in this history. Another portion of that address was devoted to the plans for the celebration of the four-hundredth anniversary of the discovery of America by Columbus, an anniversary which, it had already been decided, was to be made the occasion of an international exhibition. At the time of the delivery of Mr. Towne's address the place for this exhibition had not been finally determined, nor had the actual date been fixed. Mr. Towne strongly advocated the selection of New York City as the place, and as strongly emphasized the necessity for deferring the exposition until 1893, owing to the insufficient time available for the preparation of an adequate display in 1892. In view of the especial opportunities which the President and many of the members of the Society had just experienced in connection with the Paris exposition of 1889, the Society was placed in a position to speak with direct knowledge of the requirements and difficulties of such an undertaking, a problem of which previous experience in the United States had been obtained only in connection with the Philadelphia Centennial Exhibition of 1876.

Under the direction of the Council the Committee on Society History has arranged to present the results of its investigations to the members of the Society.

The Preliminary Report will appear in The Journal of the Society from month to month, and thus enable the matter to be open to comment during its completion. It is especially desired that any member who may be in the possession of facts or information bearing upon the various points as they are thus made public will communicate with the committee, in order that the final and completed report may have the advantage of the collaboration of the membership at large.

171 The location of the Columbian exhibition was chosen to be Chicago, but the date was fixed as 1893 for the reasons which the President of the Society so effectively urged.

172 The approach of this important exposition affected the work of the Society in two ways: first, it gave opportunity for the return of many of the courtesies extended by professional societies to the members who had visited Europe in 1889; and, second, it placed in the hands of the Society the conduct of the Mechanical Engineering Section, forming Division B, of the World's Congress Auxiliary.

173 Prior to any active work in connection with the reception of visitors to the World's Fair, however, the Society had the opportunity of joining in the welcome to members of the Iron and Steel Institute, which body, together with a number of members of the *Verein deutscher Eisenhüttenleute*, visited the United States in 1890.

174 The occupancy of the house in Thirty-first street enabled the Society to receive these guests in a manner which would otherwise not have been practicable, and permitted the renewal of some very enjoyable acquaintances which had been originated in England and Germany during the previous year.

175 In connection with the plans in contemplation for the coöperation of the several Engineering Societies at the approaching World's Fair, the provision of a general engineering headquarters at Chicago came up for consideration. The ultimate result of the discussion of this matter was the representation of the Society on a General Committee of Engineering Societies, Columbian Exposition, which committee included representatives, not only of the four National Engineering Societies, but also delegates from a number of local Engineers' Clubs and Associations; prominent among which may be mentioned the Western Society of Engineers, of Chicago.

176 The Spring Meeting of 1890 was held in Cincinnati, Ohio, in May. At this meeting the most important subjects acted upon by the Society were those relating to standard methods for conducting efficiency tests of locomotives, concerning which a committee was appointed; and the report of the committee upon standard tests and methods of testing materials.

177 The committee on a standard method of conducting duty trials of pumping-engines made its report, recommending the use of the heat-unit basis, and formulating a standard method in accordance with that basis.

178 At this meeting Prof. R. H. Thurston presented a paper upon the experimental and analytic theory of the steam engine as pro-

pounded by Hirn and Dwelshauvers, a subject which occupied the attention of the Society for several subsequent meetings. As a matter of interest it may be noted that it was at this meeting also that a paper by Mr. Willis E. Hall discussed the possibility of the operation of main-line railways by electricity, a matter which did not receive practical application for nearly a decade later. Other papers related to the theory of chimney draft, to the design of shaft governors and to the efficiency of locomotives.

179 The annual meeting of the Society for 1890 was held in Richmond, Va., in November, and was well attended.

180 As an illustration of the high standing of the Society in the opinion of the United States Government, it may be noted that the Council reported at this meeting that the Secretary of the Navy had requested the Society to appoint a commission of three to decide upon the relative merits of the designs of lathes for the new gun factory of the Ordnance Bureau. The Society appointed Messrs. John E. Sweet, S. T. Wellman, and Charles H. Morgan, who met in Washington and presented a satisfactory report to the Government.

181 The report of the finance committee at this meeting showed the affairs of the Society to be in a healthy condition, apart from the financial operations in connection with the incorporation of the Mechanical Engineers' Library Association, and the floating of the bonds which enabled the latter organization to purchase the real estate occupied by the Society.

182 The retiring president, Mr. Oberlin Smith, in his address, spoke of the engineer as a scholar and a gentleman. Other papers at the Richmond meeting included an exhaustive discussion of the subject of Chimney Draft, by Prof. R. H. Thurston, while Prof. D. Volson Wood contributed further discussion of his studies of the properties of ammonia and of sulphur dioxid. The question of artificial refrigeration was further treated in the paper of Prof. D. S. Jacobus on the experimental determination of the latent heat of ammonia, and Prof. J. E. Denton presented a paper containing a thorough investigation of the performance of a 75-ton ammonia compression refrigerating machine. Professor Thurston presented at this meeting a résumé of the opinions of many authorities as to the influence of the steam jacket on steam-engine economy. The Committee on Standard Methods of Conducting Duty Trials of Pumping Engines also presented their report in a revised form. The election of Mr. Robert W. Hunt of Chicago, as President of the Society, was announced at this meeting.

183 The summer meeting of 1891, held at Providence, R. I., was noteworthy as having the largest attendance yet recorded at any meeting, there being 300 names upon the registry list. At this meeting there was received a report from the representatives of the Society on the General Committee of Engineering Societies, Columbian Exposition, pursuant to which the Society approved of the establishment of Engineering Headquarters in Chicago during the Exposition, and held itself open to join in the conduct of an Engineering Congress when the details should be more clearly presented.

184 The papers presented at the Providence meeting included a number of excellent contributions to current subjects of importance, among which may be mentioned the discussion of Hirn's analysis of the steam engine in papers by Professors C. H. Peabody and R. C. Carpenter; a general review of the development of the various forms of calorimeters for the determination of the proportion of moisture present in steam, by Professor Carpenter; together with valuable records of tests of engines, in papers by Mr. John T. Henthorn, Prof. D. S. Jacobus, and Prof. J. E. Denton.

185 In addition to these there were presented papers upon subjects which have since been developed into greater importance than appeared at the time. Thus, Dr. Henry M. Howe gave to the Society information concerning the remarkable material, manganese steel, the result of the work of Mr. R. A. Hadfield, of Sheffield, Eng., this being one of the early alloy steels of which such effective development has since been made. Another paper was that of Mr. William R. Roney upon mechanical stokers for steam boilers, giving a general résumé of the work which had been done up to that time, together with the development of the effective system of mechanical stoking with which Mr. Roney has been so successfully identified.

186 An important paper presented at this Providence meeting was that treating of various methods for the remuneration of labor, and containing the first discussion of the since well-known "premium system" by Mr. F. A. Halsey. This paper undoubtedly had a large influence on shop economics, and Mr. Halsey's system, offering as it did a direct individual incentive based on the activity of the employee alone, has been used, either in its original form, or in some modification, in many of the manufacturing establishments of the United States and of Europe.

187 The twelfth Annual Meeting of the Society, held at the house in New York in November 1891, was noteworthy as the first which had been held in that building since the title of the property had actu-

ally been passed to the new owners, the Mechanical Engineers' Library Association.

188 The approach to the time for the participation of the Society in the Columbian Exposition appeared in the report of the committee to whom had been intrusted the best method for returning the hospitalities which had been extended to the Society by the European hosts of 1889. The substance of this report was that it seemed expedient that the four National engineering societies in the United States should unite in extending a joint invitation to the Institution of Civil Engineers, representing the British members of the professions and to the *Société des Ingénieurs Civils de France*, as representing the Continental members, besides which it should be made known to all engineering organizations in Europe that any of their members would be heartily welcomed at the homes of the various American societies and at the engineering headquarters at the exposition.

189 At this meeting of the Society important amendments to the constitution were made raising the initiation fees and annual dues in the various grades, and thus providing the increase in the income of the Society required for its extending scope and increased activity.

190 In accordance with action already taken by the Society, a committee upon standard flanges for valves, pipes, etc., was appointed at this meeting, the ultimate result of this action being the practical standardization of these mechanical elements, now generally followed.

191 The President's annual address, delivered at this meeting by Mr. Robert W. Hunt, followed a plan since very generally observed by presidents of the Society, taking the form of a review of the development of a department of industry in which the speaker had been actively engaged, the evolution of the American rolling-mill. The papers of this meeting related very largely to power-plant work, including discussions of steam engine economy, pumping-engine development, hydraulic power, electric-power distribution and chimney draft.

192 After the New York Meeting of 1891 there followed the widest departure in meetings of the Society which had occurred since its formation, the extension of the meetings to the Pacific Coast.

193 The European trip of 1889, while including meetings with the British and Continental societies did not coincide with any actual convention of the Society itself, the regular meetings for that year having been held in the United States. At the Providence Meeting in June 1891, however, Mr. C. W. Hunt suggested that a meeting on the Pacific Slope would be a desirable method of emphasizing the

national scope of the work of the Society, and after a thorough discussion of the subject by the Council, followed by a canvass of the membership by letter ballot, it was decided to hold the Spring meeting of 1892 in San Francisco.

194 As most of the members attending the convention came from eastern states, it was arranged to transport the party in a special train from New York, a plan which proved eminently satisfactory. The party included altogether 75 members, and guests, and the excursion proved in every way satisfactory to those who were privileged to take part in it. Details of the trip are included in an appendix to Vol. 13 of the Transactions, and the meeting proved a most effective means for the extension of the activities of the Society, both as regards its work and by reason of the additions to the membership from the Pacific Coast.

195 An important paper presented at this meeting was that of Prof. W. F. M. Goss describing the experimental locomotive-testing plant which had been installed at Purdue University. This plant, afterwards destroyed by fire, was the forerunner of the larger equipment which followed it at the same place, and of the still more important testing plant of the Pennsylvania Railroad Company at the St. Louis Exhibition, afterwards removed to Altoona, Pa.

196 The paper of Mr. Albert W. Stahl, U.S.N., upon the utilization of the power of ocean waves, was a valuable contribution to a department of science concerning which little information had been hitherto available, and this communication remains the most complete study of the subject since the investigations of Professor Rankine.

197 Another paper of especial interest presented at the San Francisco meeting was that of Messrs. Samuel M. Green and George I. Rockwood, discussing the theory of the latter gentleman as to the relative advantages of the compound and multi-cylinder steam engine. Mr. Rockwood had maintained that results as efficient as were obtained with the triple-expansion engine might be obtained with a two-cylinder compound engine by making the cylinder ratios of a proportion giving about the same total expansion ratio as existed in the triple-expansion engine. The paper presented by Messrs. Green and Rockwood gave the results of tests upon a triple-expansion engine so arranged that the intermediate cylinder might be cut out of action, permitting the engine to be run as a two-cylinder compound. The tests bore out the theory of Mr. Rockwood in that the quantity of steam required per horse power per hour was about the same whether the engine was operated as a compound or as a triple-expansion engine.

THE PRESENT STATUS OF MILITARY AËRONAUTICS

By George O. Squier, Ph.D.
MAJOR, SIGNAL CORPS, U. S. ARMY
Non-Member

It is a matter of first significance that The American Society of Mechanical Engineers, composed of a body of highly trained and serious minded men, should be considering in annual meeting assembled the subject of aërial navigation. Five years ago such a subject could scarcely have had a place on the list of professional papers on your program. The present period will ever be memorable in the history of the world for the first public demonstrations of the practicability of mechanical flight. In fact, at the present moment a resistless wave of enthusiasm and endeavor, sweeping away every prejudice, is passing over the entire civilized world, fixing the attention of all classes upon the problem of flight. France, Germany, and England are in a state of frenzied interest in this subject, and each period of a single month sees some new step accomplished in the march of progress. The Universal Highway is at last to be made available for the uses of mankind, with its consequent influence upon our modes of life and thought.

2 The subject of war balloons and their accessories pertains by law to the Signal Corps of the Army, and some months since an invitation was extended to the Chief Signal Officer of the Army, Gen. James Allen, to meet with you on this occasion and present to this distinguished body of practical engineers an outline of the work of the Government in this direction. On account of pressure of official duties General Allen has designated me to perform this duty, and notwithstanding a keen consciousness of personal shortcomings, yet I would be indeed lacking in sentiment if I failed to acknowledge the honor felt in appearing here today to present such

To be presented at the New York Meeting (December 1908) of The American Society of Mechanical Engineers. All papers are subject to revision.

a subject for the first time before a national body of American engineers.

3 At the outset, it must be stated that the subject is so vast in its scientific details and that data and results are being obtained so rapidly that it is manifestly impossible to present more than the merest outline of the present state of this new Science and Art within the limits of a short paper. From the earliest times men have dreamed of imitating the birds in sailing through the air, yet it is only within a very few years that the strength of materials and the mechanical construction of motors have reached a state to make power-flight possible. The industrial development of the automobile has been a powerful ally in the realization of mechanical flight, and the engineering profession finds itself equipped and ready to further the development of this great problem.

4 On December 23, 1907, the Signal Corps of the Army issued a public advertisement and specification calling for bids for furnishing the Government with a heavier-than-air flying machine. A copy of this specification is appended to this paper as of possible historical interest.

5 The conditions of this specification require that the Government be furnished with a heavier-than-air flying machine capable of carrying one passenger besides the aviator, and it must remain in the air on an endurance test for a period of one hour without landing, and must also be subjected to a speed test over a measured course of more than five miles, against and with the wind, attaining a minimum speed of 36 miles per hour. The machine must, in addition, carry fuel for a continuous flight of not less than 125 miles.

6 In preparing this specification, it was purposely sought to leave the bidder perfectly free in the methods to be employed, and he was not restricted as to type or design. At the time this specification was issued eleven months ago, the conditions were publicly regarded as being unusually severe and far beyond the state of the art at that time. That these conditions were justified has been subsequently proved, as is now well known.

7 Although the public advertisement called for but one heavier-than-air machine, yet when the bids were opened it was found possible through the coöperation of the Board of Ordnance and Fortification, to award contracts to each bidder who complied with the requirements of the law in every respect, and consequently contracts were ultimately awarded to the Wright Brothers of Dayton, Ohio, for the

sum of $25 000 for a 40-mile speed, and also to A. M. Herring of New York, for the sum of $20 000.

8 It was believed that the acceptance by the Government of each of the bids submitted instead of but one of them would serve as an additional stimulus to develop practical aviation in the United States, and at the same time serve to supply the War Department with machines needed in military service. This dual object,—to advance a new art of interest to the nation as a whole, and to secure necessary equipment for the military establishment,—has been in the past and is at present the policy of the Signal Corps of the Army.

9 The result of issuing this specification, as well as a similar one for supplying a small dirigible balloon for the preliminary training of the men of the Signal Corps, was an awakening of interest in this subject throughout the country to such an extent that the Signal Office continues to receive daily a large number of letters, plans, and models proposing manifold schemes for navigating the air.

10 The Aëronautical Division of the Office of the Chief Signal Officer of the Army was organized on July 1, 1907, and the Aëronautical Board of the Signal Corps was appointed in July of the current year for conducting tests of dirigible balloons and aëroplanes under existing contracts.

11 It should be stated that the mention of particular types of dirigible balloons and aëroplanes in this paper must not be considered as an official indorsement of these particular machines, nor the failure to mention other types be construed to indicate a lack of equal recognition of the merits of the latter. In the case of the Wright Brothers, however, it is desired to associate the Signal Corps of the Army publicly and officially with the present universal recognition of their work in advancing the Science and Art of Aviation. These results have been due to the persistence, daring, and intelligence of these American gentlemen, to whom the whole world is now paying homage. It will ever be recorded that the classic series of public demonstrations first made by Orville Wright at the Government testing grounds at Fort Myer, Va., in September, 1908, and by Wilbur Wright at Le Mans, France, made a profound impression throughout the world, and kindled especially the patriotic spirit of the American people.

12 There are two general classes of vehicles of the air, (*a*) those which depend for their support upon the buoyancy of some gas lighter than air, and (*b*) those which depend for such support upon the dynamic reaction of the air itself. These classes are designated

a Lighter-than-air types:
Free balloons, dirigible balloons or airships
b Heavier-than-air types:
Aëroplanes, orthopters, helicopters, etc.

13 It should be remarked, however, that these two general classes exhibit a growing tendency to overlap each other. For example, the latest dirigible balloons are partly operated by means of aëroplane surfaces, and are also often balanced so as to be slightly heavier than the air in which they move, employing the propeller thrust and rudder surfaces to control the altitude.

I. AËROSTATION

14 Captive and free balloons, with the necessary apparatus and devices for operating the same, have been for many years considered an essential part of the military establishment of every first-class Power. They played a conspicuous part in the siege of Paris, and were often valuable in our own Civil War. The construction and operation of aërostats are too well understood to need further attention here.

Successful Military Dirigible Balloons

FRANCE

15 Two types of dirigible balloons have been used in the French Army; first the *Patrie,* and second the *Ville de Paris.*

16 The *Patrie* was developed by Julliot, an engineer employed by the Lebaudy Brothers at their sugar refinery in Paris. A history of his work beginning in 1896 is fully given in *La Conquête de l'Air.*

THE PATRIE

17 The *Patrie,* the third of its type, was first operated in 1906. The gas bag of the first balloon was built by Surcouf at Billancourt, Paris. The mechanical part was built at the Lebaudy Sugar Refinery. Since then the gas bags have been built at the Lebaudy balloon shed at Moisson, near Paris, under the direction of their aëronaut, Juchmés. The gas bag of the *Patrie* was 197 ft. long with a maximum diameter of 33 ft. 9 in., situated about 2/5 of the length from the front; volume 111 250 cu. ft.; length approximately six diameters. This relation, together with the cigar shape, is in accordance with the plans of Colonel

Renard's dirigible, built and operated in France in 1884; the same general shape and proportions being found in the *Ville de Paris*.

18 The first Lebaudy was pointed at the rear, which is generally admitted to be the proper shape for the least resistance, but to maintain stability it was found necessary to put a horizontal and vertical plane there, so that it had to be made an ellipsoid of revolution to give attachment for these planes.

19 The ballonet for air had a capacity of 22 958 cu. ft. or about $\frac{1}{5}$ of the total volume. This is calculated to permit reaching a height of about one mile and to be able to return to the earth, keeping the gas bag always rigid. To descend from a height of one mile, gas would be released by the valve, then air pumped into the ballonet to keep the gas bag rigid, these two operations being carried on alternately. On reaching the ground from the height of one mile the air would be at the middle of the lower part of the gas bag and would not entirely fill the ballonet. To prevent the air from rolling from one end to the other when the airship pitches, thus producing instability, the ballonet was divided into three compartments by impermeable cloth partitions. Numerous small holes were pierced in these partitions through which the air finally reached the two end compartments.

20 In September, 1907, the *Patrie* was enlarged by 17 660 cu. ft. by the addition of a cylindrical section at the maximum diameter, increasing the length but not the maximum diameter.

21 The *gas bag* is cut in panels; the material is a rubber cloth made by the Continental Tire Company at Hanover, Germany. It consists of four layers arranged as follows:

	Weight oz. per square yard
a Outer layer of cotton cloth covered with lead chromate	2.5
b Layer of vulcanized rubber	2.5
c Layer of cotton cloth	2.5
d Inner layer of vulcanized rubber	2.21
Total weight	9.71

22 A strip of this cloth one foot wide tears at a tension of about 934 lb. A pressure of about 1 in. of water can be maintained in the gas bag without danger. The lead chromate on the outside is to prevent the entrance of the actinic rays of the sun which would cause the rubber to deteriorate. The heavy layer of rubber is to prevent the

leaking of the gas. The inner layer of rubber is merely to prevent deterioration of the cloth by impurities in the gas. This material has the warp of the two layers of cotton cloth running in the same direction and is called straight thread. The material in the ballonet weighs only about 7¾ oz. per sq. yd. and has a strength of about 336 lb. per running foot. When the *Patrie* was enlarged in September, 1907, the specifications for the material allowed a maximum weight of 10 oz. per sq. yd., a minimum strength of 907 lb. per running foot, and a loss of 5.1 cu. in. of hydrogen per square yard in twenty-four hours at a pressure of 1.18 in. of water. Bands of cloth are pasted over the seams inside and out with a solution of rubber to prevent leaking through the stitches.

23 *Suspension.* One of the characteristics of the *Patrie* is the "short" suspension. The weight of the car is distributed over only about 70 ft. of the length of the gas bag. To do this, an elliptical shaped frame of nickel steel tubes is attached to the bottom of the gas bag; steel cables run from this down to the car. A small hemp net is attached to the gas bag by means of short wooden cross pieces or toggles which are let into holes in a strong canvas band which is sewed directly on the gas bag. The metal frame, or platform, is attached to this net by means of toggles, so that it can be quickly removed in dismounting the airship for transportation. The frame can also be taken apart. 28 steel cables about 0.2 in. in diameter run from the frame down to the car, and are arranged in triangles. Due to the impossibility of deforming a triangle, rigidity is maintained between the car and gas bag.

24 The objection to the "short" suspension of the *Patrie* is the deformation of the gas bag. A distinct curve can be seen in the middle.

25 *The Car.* The car is made of nickel steel tubes (12 per cent nickel). This metal gives the greatest strength for minimum weight. The car is boat-shaped, about 16 ft. long, about 5 ft. wide, and 2½ ft. high. About 11 ft. separate the car from the gas bag. To prevent any chance of the fire from the engine communicating with the hydrogen, the steel framework under the gas bag is covered with a non-combustible material.

26 The pilot stands at the front of the car, the engine is in the middle, the engineer at the rear. Provision is made for mounting a telephotographic apparatus, and for a 100-candle-power acetylene search-light. A strong pyramidal structure of steel is built under the car, pointing downward. In landing the point comes to the ground

first and this protects the car, and especially the propellers, from being damaged. The car is covered to reduce air resistance. It is so low, however, that part of the equipment and most of the bodies of those inside are exposed, so that the total resistance of the car is large.

27 *The Motor.* The first Lebaudy had a 40 h. p. Daimler-Mercedes benzine motor. The *Patrie* was driven by a 60 to 70 h.p., 4-cylinder Panhard and Levassor benzine motor, making 1000 r.p.m.

28 *The Propellers.* There are two steel propellers 8½ ft. in diameter (two blades each) placed at each side of the engine, thus giving the shortest and most economical transmission. To avoid any tendency to twist the car, the propellers turn in opposite directions. They are "high speed," making 1000 to 1200 r.p.m.

29 The gasolene tank is placed under the car inside the pyramidal frame. The gasoline is forced up to the motor by air compression. The exhaust is under the rear of the car pointing down and is covered with a metal gauze to prevent flames coming out. The fan which drives the air into the ballonet is run by the motor, but a dynamo is also provided so that the fan can always be kept running even if the motor stops. This is very essential as the pressure must be maintained inside the gas bag so that the latter will remain rigid and keep its form. There are five valves in all, part automatic and part both automatic and also controlled from the car with cords. The valves in the ballonet open automatically at less pressure than the gas valves, so that when the gas expands all the air is driven out of the ballonet before there is any loss of gas. The ballonet valves open at a pressure of about 0.78 in. of water, the gas valves at about 2 in.

30 *Stability.* Vertical stability is maintained by means of fixed horizontal planes. One having a surface of 150 sq. ft. is attached at the rear of the gas bag, and due to its distance from the center of gravity is very efficient. The elliptical frame attached under the gas bag has an area of 1 055 sq. ft. but due to its proximity to the center of gravity, has little effect on the stability. Just behind the elliptical frame is an arrangement similar to the feathering on an arrow. It consists of a horizontal plane of 150 sq. ft., and a vertical plane of 113 sq. ft. To maintain horizontal stability, that is, to enable the airship to move forward in a straight line without veering to the sides, fixed vertical planes are used. One runs from the center to the rear of the elliptical frame and has an area of 108 sq. ft.

31 In addition to the vertical surface of 113 sq. ft. at the rear of the elliptical frame, there is a fixed plane of 150 sq. ft. at the rear of

the gas bag. To fasten the two perpendicular planes at the rear of the gas bag, cloth flaps are sewed directly on the gas bag. Nickel steel tubes are placed in the flaps which are then laced over the tubes. With these tubes as a base, a light tube and wire framework is attached and water-proof cloth laced on this framework. Additional braces run from one surface to the other and from each surface to the gas bag. The rudder is at the rear under the gas bag. It has about 150 sq. ft. and is balanced.

32 A movable horizontal plane near the center of gravity, above the car, is used to produce rising or descending motion, or to prevent an involuntary rising or falling of the airship due to expansion or contraction of the gas or to other causes. After the adoption of this movable horizontal plane, the loss of gas and ballast was reduced to a minimum. Ballast is carried in 10 and 20 lb. sand bags. A pipe runs through the bottom of the car from which the ballast is thrown.

33 There are two long guide ropes, one attached at the front of the elliptical frame and the other on the car. On landing, the one in front is seized first so as to hold the airship with the head to the wind. The motor may then be stopped and the descent made by pulling down on both guide ropes. A heavy rope, 22 ft. long, weighing 110 lb. is attached on the end of a 164 ft. guide rope. This can be dropped out on landing to prevent coming to the ground too rapidly. The equipment of the car includes a "siren," speaking trumpet, carrier pigeons, iron pins and a rope for anchoring the airship, reserve supply of fuel and water, and fire extinguisher.

34 After being enlarged in September, 1907, the *Patrie* made a number of long trips at an altitude of 2 500 to 3 000 ft. In November 1907, she went from Paris to Verdun, near the German frontier, a distance of about 175 miles, in about 7 hours, carrying four persons. This trip was made in a light wind blowing from the northeast. Her course was east, so that the wind was unfavorable. On Friday, November 29, 1907, during a flight near Verdun, the motor stopped due to difficulty with the carburetter. The airship drifted with the wind to a village about 10 miles away where she was safely landed. The carburetter was repaired on the 30th. Soon after, a strong wind came up and tore loose some of the iron pickets with which it was anchored. This allowed the airship to swing broadside to the wind; it then tilted over on the side far enough to let some of the ballast bags fall out. The 150 or 200 soldiers who were holding the ropes were pulled along the ground until directed by the officer in charge to let go. After being released, it rose and was carried by the wind across the

north of France, the English Channel, and into the north of Ireland. It struck the earth there, breaking off one of the propellers and then drifted out to sea.

THE REPUBLIQUE

35 This is the latest of the French military dirigible balloons, and differs but slightly from its predecessor, the *Patrie*. The volume has been increased by about 2 000 cu. ft. The length has been reduced to 200 ft. and the maximum diameter increased to 35½ ft. The shape of the gas bag accounts for the 2 000 additional cubic feet of volume. The motor and propellers are as in the *Patrie*. The total lifting capacity is 9 000 lb., of which 2 700 lb. are available for passengers, fuel, ballast, instruments, etc. Its best performance was a 125-mile flight made in 6½ hours against an unfavorable wind.

36 The material for the gas bag of the new airship was furnished by the Continental Tire Company. It is made up as follows:

	Weight oz. per square yard
Outer yellow cotton layer	3.25
Layer of vulcanized rubber	3.25
Layer of cotton cloth	3.25
Inner layer of rubber	0.73
Total weight	10.48

37 It is interesting to note the changes which this type has undergone since the first one was built. The *Jaune*, constructed in 1902–03, was pointed at the rear and had no stability plane there; later it was rounded off at the rear and a fixed horizontal plane attached. Finally a fixed vertical plane was added. The gas bag has been increased in capacity from 80 670 cu. ft. to about 131 000 cu. ft. The manufacturers have been able to increase the strength of the material of which the gas bag is made, without materially increasing the weight. The rudder has been altered somewhat in form. It was first pivoted on its front edge, but later on a vertical axis, somewhat to the rear of this edge. With the increase in size, has come an increase in carrying capacity and consequently a greater speed and more widely extended field of action.

VILLE DE PARIS

38 This airship was constructed for Mr. Deutsch de la Meurthe, of Paris, who has done a great deal to encourage aërial navigation. The

first *Ville de Paris* was built in 1902, on plans drawn by Tatin, a French aëronautical engineer. It was not a success. Its successor was built in 1906, on plans of Surcouf, an aëronautical engineer and balloon builder. The gas bag was built at his works in Billancourt, the mechanical part at the Voisin shop, also in Billancourt. The plans are based on those of Colonel Renard's airship, the *France*, built in 1884, and the *Ville de Paris* resembles the older airship in many particulars. In September, 1907, Mr. Deutsch offered the use of his airship to the French Government. The offer was accepted, but delivery was not to be made except in case of war or emergency. When the *Patrie* was lost in November, 1907, the military authorities immediately took over the Deutsch airship.

39 *Gas Bag.* The gas bag is 200 ft. long for a maximum diameter of $34\frac{1}{2}$ ft., giving a length of about 6 diameters, as in the *France* and the *Patrie*. Volume 112 847 cu. ft. maximum diameter at about $\frac{2}{5}$ of the distance fromthefront, approximately, as in the *Patrie*. The middle section is cylindrical with conical sections in front and rear. At the extreme rear is a cylindrical section with eight smaller cylinders attached to it. The ballonet has a volume of 21 192 cu. ft., or about $\frac{1}{5}$ of the whole volume, the same proportion found in the *Patrie*. The ballonet is divided into three compartments from front to rear. The division walls are of permeable cloth, and are not fastened to the bottom so that when the middle compartment fills with air, and the ballonet rises, the division walls are lifted up from the bottom of the gas bag, and there is free communication between the three compartments. The gas bagis madeup of a series of strips perpendicular to a meridian line. These strips run around the bag, their ends meeting on the under meridian. This is known as the "brachistode" method of cutting out the material, and has the advantage of bringing the seams parallel to the line of greatest tension. They are therefore more likely to remain tight and not allow the escape of gas. The disadvantage lies in the fact that there is a loss of $33\frac{1}{3}$ per cent of material in cutting. The material was furnished by the Continental Tire Company, and has approximately the same tensile strength and weight as that used in the *Patrie*. It differs from the other in one important feature—it is diagonal-thread, that is, the warp of the outer layer of cotton cloth makes an angle of 45 deg. with the warp of the inner layer of cotton cloth. The result is to localize a rip or tear in the material. A tear in the straight thread material will continue along the warp, or the weave, until it reaches a seam.

40 *Valves.* There are five in all, made of steel, about fourteen inches in diameter; one on the top connected to the car by a cord, operated by hand only; two near the rear underneath. These are automatic but can be operated by hand from the car. Two ballonet valves directly under the middle are automatic and are also operated from the car by hand. The ballonet valves open automatically at a pressure of $\frac{3}{8}$ in. of water, the gas valves open at a higher pressure.

41 *Suspension.* This airship has the "long" suspension. That is, the weight is distributed along practically the entire length of the gas bag. A doubled band of heavy canvas is sewn with six rows of stitches along the side of the gas bag. Hemp ropes running into steel cables transmit most of the weight of the car to these two canvas bands and thus to the gas bag. On both sides and below these first bands are two more. Lines run from these to points half way between the gas bag and the car, then radiate from these points to different points of attachment on the car. This gives the triangular or non-deformable system of suspension, which is necessary in order to have the car and gas bag rigidly attached to each other. With this "long" suspension, the *Ville de Paris* does not have the deformation so noticeable in the gas bag of the *Patrie.*

42 *The Car.* This is in the form of a trestle. It is built of wood with aluminum joints and 0.12 in. wire tension members. It is 115 ft. long, nearly 7 ft. high at the middle, and a little over $5\frac{1}{2}$ ft. wide at the middle. It weighs 660 lb. and is considered unnecessarily large and heavy The engine and engineer are well to the front, the aëronaut with steering wheels is about at the center of gravity.

43 *Motor.* The motor is a 70 to 75 h.p. "Argus," and is exceptionally heavy.

44 *Propeller.* The propeller is placed at the front end of the car. It thus has the advantage of working in undisturbed air; the disadvantage is the long transmission and difficulty in attaching the propeller rigidly. It has two blades and is 19.68 ft. long with a pitch of 26.24 ft. The blades are of cedar with a steel arm. The propeller makes a maximum of 250 turns per minute when the engine is making 900 rev. Its great diameter and width compensate for its small speed.

45 *Stability.* This is maintained entirely by the cylinders at the rear. Counting the larger one to which the smaller ones are attached, there are five, arranged side by side corresponding to the horizontal planes of the *Patrie,* and five vertical ones corresponding to the *Patrie's* vertical planes. The volume of the small cylinders is so calculated

that the gas in them is just sufficient to lift their weight, so they neither increase or decrease the ascensional force of the whole. The horizontal projection of these cylinders is 1076 sq. ft. The center of this projection is 72 ft. from the center of gravity of the gas. The great objection to this method of obtaining stability, is the air resistance due to these cylinders, and consequent loss of speed. The stability of the *Ville de Paris* in a vertical plane is said to be superior to that of the *Patrie*, due to the fact that the stability planes of the latter do not always remain rigid. The independent velocity of the *Ville de Paris* probably never exceeded 25 miles an hour.

46 *The Rudder*. The rudder has a double surface of 150 sq. ft. placed at the rear end of the car, 72 ft. from the center of gravity. It is not balanced, but is inclined slightly to the rear so that its weight would make it point directly to the rear if the steering gear should break. Two pairs of movable horizontal planes, one at the rear of the car having 43 sq. ft., and one at the center of gravity (as on the *Patrie*) having 86 sq. ft. serve to drive the airship up or down without losing gas or ballast.

47 *Guide Ropes*. A 400 ft. guide rope is attached at the front end of the car. A 230 ft. guide rope is attached to the car at the center of gravity.

48 About thirty men are required to maneuver the *Ville de Paris* on the ground. The pilot has three steering wheels, one for the rudder and two for the movable horizontal planes. The instruments used are an aneroid barometer, a registering barometer giving heights up to 1600 ft. and an ordinary dynamometer which can be connected either with the gas bag or ballonet by turning a valve. A double column of water is also connected to the tube to act as a check on the dynamometer. Due to the vibration of the car caused by the motor, these instruments are suspended by rubber attachments. Even with this arrangement, it is necessary to steady the aneroid barometer with the hand in order to read it. The vibration prevents the use of the statoscope.

ENGLAND

MILITARY DIRIGIBLE NO. 1

49 The gas bag of this airship was built about five years ago by Colonel Templar, formerly in command of the aëronautical establishment at Aldershot. His successor, Colonel Capper built the mechanical part during the spring and summer of 1907, with the assistance of Mr.

S. F. Cody, a mechanical engineer. It was operated by Colonel Capper as pilot, with Mr. Cody in charge of the engine. Several ascents were made at Aldershot. In October 1907, they made a trip from Aldershot to London, a distance of about 40 miles, landing at the Crystal Palace. For several days the rain and wind prevented attempting the return journey. On October 10 a strong wind threatened to carry away the airship, so the gas bag was cut open by the sergeant in charge.

50 *Gas Bag.* This is made of eight layers of gold beater's skin. It is cylindrical in shape with spherical ends. Volume 84 768 cu. ft.; length 111½ ft.; maximum diameter, 31½ ft. The elongation therefore is only about 3¾. There is no ballonet, but due to the toughness of the gold beater's skin, a much higher pressure can safely be maintained than in gas bags of rubber cloth. Without a ballonet, however, it would not be safe to rise to the heights reached by the *Patrie.*

51 *Valves.* The valves are made of aluminum and are about 12 in. in diameter.

52 *Suspension.* In this airship they have succeeded in obtaining a "long" suspension with a short boat-shaped car, a combination very much to be desired, as it distributes the weight over the entire length of the gas bag and gives the best form of car for purposes of observation and for maneuvering on the ground. To obtain this combination they have had to construct a very heavy steel framework which cuts down materially the carrying capacity, and moreover, this framework adds greatly to the air resistance. This is the only airship in Europe having a net work to support the car. In addition, four silk bands are passed over the gas bag and wires run from their extremities down to the steel frame. This steel frame is in two tiers; the upper is rectangular in cross-section and supports the rudder and planes; the lower part is triangular in cross-section and supports the car. The joints are aluminum.

53 *The Car.* This is of steel and is about thirty feet long. To reduce air resistance, the car is covered with cloth.

54 *Motor.* A 40 to 50 h.p. 8-cylinder Antoinette motor is used. It is set up on top of the car. The benzine tanks are supported above in the framework. Gravity feed is used.

55 *Propellers.* There are two propellers, one on each side, with two blades each, as in the *Patrie.* They are made of aluminum, 10 ft. in diameter, and make 700 r.p.m. The transmission is by belt.

56 *Stability.* This is maintained by means of planes. At the extreme rear is a large fixed horizontal plane. In front of this is a pair of

hinged horizontal planes. Under this is the hexagonal shaped rudder. It is balanced. Two pairs of movable horizontal planes, 8 ft. by 4 ft., each placed at the front serve to guide the airship up and down, as in the *Patrie* and *Ville de Paris*. These planes have additional inclined surfaces which are intended to increase the stability in a vertical plane. All these planes, both fixed and movable, are constructed like kites, of silk stretched on bamboo frames. The guide rope is 150 ft. long. Speed attained, about 16 miles per hour. This airship with a few improvements added has been in operation the past few months. The steel framework connecting the gas bag to the car, is now entirely covered with canvas, which must reduce the resistance of the air very materially. The canvas covering, enclosing the entire bag, serves as a reinforcement to the latter and at the same time gives attachment to the suspension underneath. It is reported that a speed of 20 miles an hour has been attained with the reconstructed airship.

57 A pyramidal construction similar to that on the *Patrie* has been built under the center of the car to protect the car and propellers on landing. A single movable horizontal plane placed at the front end of the car and operated by the pilot, controls the vertical motion.

GERMANY

58 Three different types of airships are being developed in Germany. The *Gross* is the design of Major Von Gross, who commands the Balloon Battalion at Tegel near Berlin. The *Parseval* is being developed by Major Von Parseval, a retired German Officer, and the *Zeppelin* is the design of Count Zeppelin, also a retired officer of the German Army.

THE GROSS

59 The first airship of this type made its first ascension on July 23, 1907. The mechanical part was built at Siemen's Electrical Works in Berlin; the gas bag by the Riedinger firm in Augsburg.

60 *Gas Bag.* The gas bag is made of rubber cloth furnished by the Continental Tire Company similar to that used in the *Ville de Paris*. It is diagonal-thread, but there is no inner layer of rubber, as they do not fear damage from impurities in the hydrogen gas. Length, 131¼ ft.; maximum diameter, about 39⅜ ft.; volume 63 576 cu. ft.; the elongation is about 3⅓. The form is cylindrical with spherical cones at the ends, the whole being symmetrical.

61 *Suspension.* The suspension is practically the same as that of the *Patrie.* A steel and aluminum frame is attached to the lower part of the gas bag, and the car is suspended on this by steel cables. The objection to this system is even more apparent in the *Gross* than in the *Patrie.* A marked dip along the upper meridian of the gas bag shows plainly the deformation.

62 *The Car.* The car is boat-shaped like that of the *Patrie.* It is suspended thirteen feet below the gas bag.

63 *Motor.* The motor is a 20 to 24 h.p., 4-cylinder "Daimler-Mercedes."

64 *Propellers.* There are two propellers $8\frac{2}{10}$ ft. in diameter, each having two blades. They are placed one on each side, but well up under the gas bag near the center of resistance. The transmission is by belt. The propellers make 800 r.p.m.

65 *Stability.* The same system, with planes, is used in the *Von Gross* as in the *Patrie,* but it is not nearly so well developed. At the rear of the rigid frame attached to the gas bag, are two fixed horizontal planes, one on each side. A fixed vertical plane runs down from between these horizontal planes, and is terminated at the rear by the rudder. A fixed horizontal plane is attached on the rear of the gas bag as in the *Patrie.* The method of attachment is the same, but the plane is put on before inflation in the Gross airship, afterwards in the *Patrie.* The stability of the Gross airship in a vertical plane is reported to be very good, but it is said to veer considerably in attempting to steer a straight course.

66 The many points of resemblance between this dirigible and the Lebaudy type are worthy of notice. The suspension or means of maintaining stability, and the disposition for driving are in general the same. As first built, the *Gross* had a volume of 14 128 cu. ft. less than at present, and there was no horizontal plane at the rear of the gas bag. Its maximum speed is probably fifteen miles per hour. As a result of his experiments of 1907, Major Von Gross has this year produced a perfected airship built on the same lines as his first, but with greatly increased volume and dimensions. The latest one has a volume of 176 000 cu. ft., is driven by two 75 h.p. Daimler motors, and has a speed of 27 miles per hour.

67 On September 11 of this year, the Gross airship left Berlin at 10.25 p.m., carrying four passengers, and returned the next day at 11.30 a.m., having covered 176 miles in the period of a little over 13 hours. This is the longest trip, both in point of time and distance ever made by any airship returning to the starting point.

THE PARSEVAL

68 The Parseval airship is owned and controlled by the Society for the Study of Motor Balloons. This organization, composed of capitalists, was formed practically at the command of the Emperor who is very much interested in aërial navigation. The Society has a capital of 1 000 000 marks, owns the Parseval patents and is ready to construct airships of the Von Parseval type. The present airship was constructed by the Riedinger firm at Augsburg, and is operated from the balloon house of this Society at Tegel, adjoining the military balloon house.

69 The gas bag is similar in construction to that of the "*Drachen*" balloon, used by the army for captive work. Volume, 113 000 cu. ft., length 190 ft., maximum diameter 30½ ft. It is cylindrical in shape, rounded at the front end and pointed at the rear. The material was furnished by the Continental Tire Company. It is diagonal-thread, weighing about $11\frac{2}{10}$ oz. per sq. yd. and having a strength of about 940 lb. per running foot. Its inner surface is covered with a layer of rubber.

70 *Ballonets.* There are two ballonets, one at each end, each having a capacity of 10 596 cu. ft. The material in the ballonet weighs about 8¼ oz. per sq. yd., the cotton layers being lighter than in the material for the gas bag. Air is pumped into the rear ballonet before leaving the ground, so that the airship operates with the front end inclined upward. The air striking underneath, exerts an upward pressure, as on an aëroplane, and thus adds to its lifting capacity. Air is pumped into the ballonets from a fan operated by the motor. A complex valve just under the middle of the gas bag, enables the engineer to drive air into either, or both ballonets. The valves also act automatically and release air from the ballonets at a pressure of about 0.9 in. of water.

71 In the middle of the top of the gas bag, is a valve for releas- the gas. It can be operated from the car, and opens automatically at a pressure of about 2 in. of water. Near the two ends and on opposite sides, are two rip strips controlled from the car by cords.

72 *Suspension.* The suspension is one of the characteristics of the airship, and is protected by patents. The car has four trolleys, two on each side, which run on two steel cables. The car can run backwards and forwards on these cables, thus changing its position with relation to the gas bag. This is called "loose" suspension. Its object is to allow the car to take up, automatically, variations in

thrust due to the motor, and variations in resistance due to the air. Ramifications of hemp rope from these steel cables are sewn onto a canvas strip which in turn is sewn onto the gas bag. This part of the suspension is the same as in the Drachen balloon. The weight is distributed over the entire length of the gas bag.

73 *The Car.* The car is 16.4 ft. long and is built of steel tubes and wire. It is large enough to hold the motor and three men, though four or five may be taken.

74 *Motor.* The motor is a 110 h.p. Daimler-Mercedes. Sufficient gasolene is carried for a run of 12 hours.

75 *Propeller.* The propeller, like the suspension, is peculiar to this airship and is protected by patents. It has four cloth blades which hang limp when not turning. When the motor is running, these blades, which are carefully weighted with lead at certain points, assume the proper position due to the various forces acting. The diameter is 13¾ ft. The propeller is placed above the rear of the car near the center of resistance. Shaft transmission is used. The propeller makes 500 r.p.m. to 1000 of the motor. There is a space of 6½ ft. from the propeller blades to the gas bag, the bottom of the car being about 30 ft. from the gas bag. This propeller has the advantage of being very light. Its position, so far from the engine, necessarily incurs a great loss of power in transmission.

76 The steering wheel at the front of the car, has a spring device for locking it in any position.

77 The 1908 model of this airship was constructed for the purpose of selling it to the Government. Among other requirements is a 12 hour flight without landing, and a sufficient speed to maneuver against a 22-mile wind. A third and larger airship of this type is now under construction.

THE ZEPPELIN

78 The Zeppelin airship, of which there have been four, differs from all others in that the envelope is rigid. Sixteen separate gas bags are contained in an aluminum alloy framework having 16 sides, covered with a cotton and rubber fabric. The pressure of the air is taken up by this framework instead of by the gas bags. The gas bags are not entirely filled, thus leaving room for expansion.

79 The rigid frame is 446 ft. long, 42½ ft. in diameter, and has ogival-shaped ends. It is braced about every 45 ft. by a number of rods crossing near the center, giving a cross section resembling a bicycle wheel. Vertical braces are placed at intervals the entire

length of the frame. The 16 gas bags are completely separated from each other by partitions of sheet aluminum. Under the framework is a triangular truss running nearly the entire length, the sides of the triangle being about 8 ft. The total volume of the gas bags is 460 000 cu. ft. which gives a gross lift of about 32 000 lb.

80 *Suspension.* The two cars are rigidly attached directly to the frame of the envelope, and a very short distance below it.

81 *Cars.* The two cars are built like boats. They are about 20 ft. long, 6 ft. wide, 3½ ft. high; are placed about 100 ft. from each end and are made of the same aluminum alloy. To land the airship, it is lowered until the cars float on the water, when it can be towed like a ship. A third car is built into the keel directly under the center of the framework, and is for passengers only.

82 *Motors.* The power is furnished by two 110 h.p. Daimler-Mercedes motors, one placed on each car. Each weighs about 550 lb.; sufficient fuel for a 60 hours run can be carried.

83 *Propellers.* A pair of three-bladed metal propellers about 15 ft. in diameter is placed opposite each car, firmly attached to the frame of the envelope at the height of the center of resistance where they are most efficient.

84 *Stability.* In addition to the long V-shaped keel under the rigid frame, on each side at the rear of the frame are two nearly horizontal planes, while above and below the rear end are vertical fins.

85 *Steering.* A large vertical rudder is attached at the extreme end of the rigid frame, and an additional one is placed between each set of horizontal planes on the sides. For vertical steering, there are four sets of movable horizontal planes placed near the ends of the rigid frame, about the height of the propellers. Each set consists of four horizontal planes placed one above the other and connected with rods, so that they work on the principle of a shutter. These horizontal rudders serve another very important purpose, due to the reaction of the air. When these planes are set at an angle of 15 deg. and the airship is making a speed of 35 miles per hour, an upward pressure of over 1700 lb. is exerted, and consequently all the gas in one compartment could escape and yet by the manipulation of these planes, the airship could return safely to its starting point.

86 Its best performances were two long trips made during the past summer. The first, July 4th, lasted exactly twelve hours, during which time it covered a distance of 235 miles, crossing the mountains to Lucerne and Zurich, and returning to the balloon house at Fried-

richshafen on Lake Constance. The average speed on this trip was 32 miles per hour. On August 4 this airship attempted a 24-hour flight, which was one of the requirements made for its acceptance by the Government. It left Friedrichshafen in the morning with the intention of following the Rhine as far Mainz, and then returning to its starting point straight across the country. A stop of 4 hours and 30 minutes was made in the afternoon of the first day on the Rhine, to repair the engine. On the return, a second stop was found necessary near Stuttgart, due to difficulties with the motors and the loss of gas. While anchored to the ground a storm came up, and broke loose the anchorages; and as the balloon rose in the air it exploded and took fire, due to causes which have never been actually determined and published, and fell to the ground, resulting in its complete destruction. On this journey, which lasted in all 31 hours and 15 minutes, the airship was in the air 20 hours and 45 minutes, and covered a total distance of 378 miles.

87 The patriotism of the German nation was aroused. Subscriptions were immediately opened and in a short space of time $1 000 000 had been raised. A Zeppelin Society was formed to direct the expenditure of this fund. $85 000 has been expended for land near Friedrichshafen; shops are being constructed and it has been announced that within one year, the construction of 8 airships of the Zeppelin type will be completed. Recently the Crown Prince of Germany made a trip in the *Zeppelin No. 3,* which had been called back into service, and within a very few days the Emperor of Germany visited Friedrichshafen for the purpose of seeing the airship in flight. He decorated Count Zeppelin with the Order of the Black Eagle. German patriotism and enthusiasm has gone further, and the "German Association for an Aërial Fleet" has been organized in sections throughout the country. It announces its intention of building fifty garages (hangars) for housing airships.

UNITED STATES

SIGNAL CORPS DIRIGIBLE NO. 1

88 Due to lack of funds, the United States Government has not been able to undertake the construction of an airship sufficiently large and powerful to compete with those of European nations. However, specifications were sent out last January for an airship not over 120 ft. long and capable of making 20 miles per hour. Contract

was awarded to Capt. Thomas S. Baldwin, who delivered an airship last August to the Signal Corps, the description of which follows:

89 *Gas Bag.* The gas bag is spindle shaped, 96 ft. long, maximum diameter 19 ft. 6 in. with a volume of 20 000 cu. ft. A ballonet for air is provided inside the gas bag, and has a volume of 2 800 cu. ft. The material for the gas bag is made of two layers of Japanese silk, with a layer of vulcanized rubber between.

90 *Car.* The car is made of spruce, and is 66 ft. long, 2½ ft. wide, and 2½ ft. high.

91 *Motor.* The motor is a 20 h.p. water-cooled Curtiss make.

92 *Propeller.* The propeller is at the front end of the car, and is connected to the engine by a steel shaft. It is built up of spruce, has a diameter of 10 ft. 8 in. with a pitch of 11 ft., and turns at the rate of 450 r.p.m. A fixed vertical surface is provided at the rear end of the car to minimize veering, and a horizontal surface attached to the vertical rudder at the rear tends to minimize pitching. A double horizontal surface controlled by a lever and attached to the car in front of the engine, serves to control the vertical motion and also to minimize pitching.

93 The position of the car very near to the gas bag, is one of the features of the Government dirigible. This reduces the length and consequently the resistance of the suspension, and places the propeller thrust near the center of resistance.

94 The total lifting power of this airship is 1350 lb. of which 500 lb. are available for passengers, ballast, fuel, etc. At its official trials a speed of 19.61 miles per hour was attained over a measured course ,and an endurance run lasting 2 hours, during which 70 per cent of the maximum speed was maintained.

95 *Dirigible No.* 1. as this airship has been named, has already served a very important purporse in initiating officers of the Signal Corps in the construction and operation of a dirigible balloon. With the experience now acquired, the United States Government is in a position to proceed with the construction and operation of an airship worthy of comparison with any now in existence, but any efforts in this direction must await the action of Congress in providing the necessary funds.

BALLOON PLANT AT FORT OMAHA, NEBRASKA

96 In anticipation of taking up the subject of aëronautics on a scale commensurate with its importance, a complete plant has been

constructed at the Signal Corps post at Fort Omaha, Nebraska. This plant comprises a steel balloon house 200 ft. long, 84 ft. wide, and 75 ft. high; that is, large enough to house a dirigible balloon of the size of the new French Military Airship *Le Republique*. For furnishing hydrogen gas, an electrolytic plant has been installed capable of furnishing 3000 cu. ft. of gas per hour. A gasometer of 50 000 cu. ft. capacity has been provided to store a sufficient supply of gas for emergencies.

97 In connection with the hydrogen plant, is a compressor for charging under pressure the steel tubes in which the gas is transported. A hydraulic pump for testing steel tubes at high pressure is a part of this equipment. A steel wireless telegraph tower 200 ft. high has been completed, and probably will be used in connection with wireless experiments with dirigible balloons.

Some General Considerations Which Govern the Design of a Dirigible Balloon

BUOYANCY AND SHAPE

98 Although many aërodynamic data are needed for the proper design of a dirigible airship, yet the experience already available in the construction and performance of such ships built on different plans is sufficient to enable the engineer to proceed with the design of a dirigible balloon to accomplish definite results along fairly accurate lines. In the case of this class of lighter-than-air ships the following general equation obtains:

$$W - w = V\left(\sigma - \frac{\sigma}{n}\right) \tag{1}$$

where

W = weight of balloon, envelope, car, and aëronauts
V = volume of balloon
σ = density of the air
n = density of air as compared with gas
w = weight of air displaced by car and aëronauts and envelope of balloon.

99 If we call the weight of the gas in the balloon M, then we can write this equation in the following manner:

$$W + M = w + nM$$

from which we find that

$$M = \frac{W - w}{n - 1} \tag{2}$$

and

$$V = \left(\frac{W - w}{\sigma}\right)\left(\frac{n}{n - 1}\right) \tag{3}$$

thus obtaining the volume of gas required. If the volume of the gas-bag, car, aëronauts, etc. = v, then $w = v\sigma$; so that (3) may be written

$$V = \left(\frac{W - v\sigma}{\sigma}\right)\left(\frac{n}{n - 1}\right) \tag{4}$$

100 Thus far, certainly, no dirigible balloon has ever been developed which, has attained an independent speed greater than 40 miles per hour. It will readily be admitted that an airship so designed as to reach a speed of 50 or 60 miles per hour would be regarded as a most decided step forward in the art, since this difference of velocity is just the increment needed to place such craft on a practical basis capable of maneuvering in the air in all ordinary weather. This advancement, although requiring much consideration, would fully compensate in practical results.

101 The first point to be decided upon in the design of an airship is the method of maintaining the shape of the gas-bag against the pressure encountered at the maximum velocity to be attained. There are two schools of design in this respect, each having its adherents. One maintains the shape of the gas-bag by a rigid interior frame, and the other by means of the internal pressure of the gas itself.

102 Upon the selection of the type depends to a large extent the particular shape of the envelope. If the envelope is to maintain its shape by interior pressure of gas, evidently it must be so designed that the maximum pressure of the air developed at the speed contemplated shall not be sufficient to cause deformation of any part of the envelope. This can be effected only by making the uniform internal pressure at least equal to the maximum external pressure. Since the maximum external pressure occurs over the prow of the air-ship, this evidently is the particular part which must receive most careful attention with this system.

103 The desirable shape of head would evidently be one where the distribution of external pressure due to air resistance at the

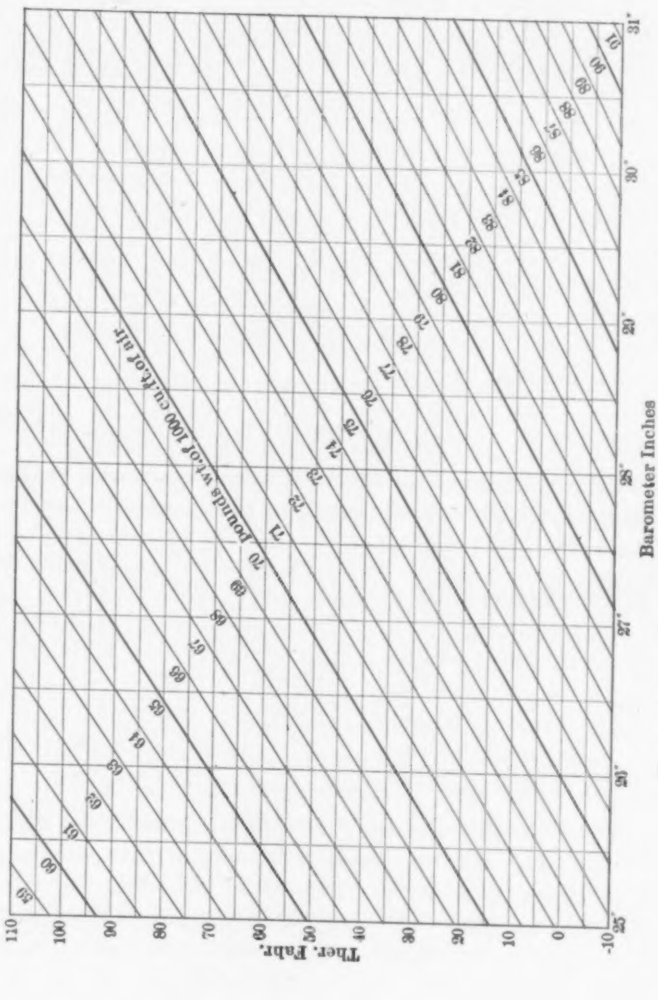

DIAGRAM FOR FINDING THE ASCENSIONAL FORCE OF GASES

velocity used is uniform. In addition to preventing deformation of the gas-bag, a prime requisite also is that the shape shall be such that the total resistance, comprising head resistance and skin-friction shall be a minimum for a given displacement and velocity.

104 This immediately forces the question of the law of resistance of the air. On this subject there are numerous aërodynamic data for low velocities, and also for very high velocities, but such data are incomplete for the range of velocities here considered.

105 In fact, the law of resistance of the air for surfaces of revolution as experimentally determined, is known to vary not with any constant power of the velocity, but by a range of exponents from the first to the cube, if not higher. For example, in the enormous velocities attained by modern artillery, where bodies weighing a ton or more, are hurled through the air at 2000 ft. per second, it is known that the physical phenomena become entirely different in nature from those found when dealing with moderate velocities such as are met in transportation devices.

RESISTANCE OF THE AIR TO THE MOTION OF A PROJECTILE

106 In the expression for the retardation of oblong projectiles the velocity enters with an exponent, n, whose accepted values are as follows:

		Ft. per second		Miles per hour
$n = 1.55$	for velocities greater than	2600	=	1773
$n = 1.7$	for velocities between....	2600 and 1800	=	1773 and 1227
$n = 2.$	for velocities between....	1800 and 1370	=	1227 and 934
$n = 3.$	for velocities between....	1370 and 1230	=	934 and 836
$n = 5.$	for velocities between....	1230 and 970	=	836 and 639
$n = 3.$	for velocities between....	970 and 790	=	639 and 592
$n = 2.$	for velocities less than ...	790	=	592

107 *14-in. and 16-in. Guns.* The 14-in. guns fire a projectile weighing 1660 lbs. Service muzzle velocity 2150 f. s., which gives with an elevation of 15 deg. a range of 15 000 yds.

108 The 16 in. guns fire a projectile weighing 2400 lbs. The Service muzzle velocity is 2150 f. s., or 1465 miles per hour, which gives, for an elevation of 15 deg. a range of 15 558 yd., or nearly 9 miles.

ANALOGY TO AIRSHIP

109 Great guns are now constructed which throw masses of steel weighing as high as 2400 lb. to maximum distances approximating

15 to 20 miles, and with such high momentum that ordinary winds have little effect, as shown by the remarkable target practice of the Army and Navy. The shapes of these heavier-than-air flying machines are figures of revolution, and the longitudinal and lateral stability are maintained by imparting to the projectile a rotary motion about its longer axis by means of the rifling inside the bore of the gun. Such machines are 5000 or 6000 times heavier than air and travel at speeds far beyond any other engine constructed by man. No peripheral speeds attained with any machinery approach these velocities.

110 It is noted that these projectile air-machines have a mass two and a half times that of the Wright Aëroplane, and attain a velocity through the air thirty-six times as great.

111 It thus appears that the resistance of the air to the motion of bodies through it is in reality a complicated function of the velocity, and the best that can be said is that this velocity varies as a constant power only within certain limited ranges. In the velocities considered for airships, it is approximate to regard the resistance as varying as the square.

112 As the velocity increases the form of the head becomes more and more important, and moderate velocities lead to a shape approximating torpedo form, which is well known. In very high speed projectiles the shape of the rear is not so important, since the velocity is so much greater than the velocity of sound in air, that a partial vacuum is formed behind the projectile which cannot well be obviated.

113 If the rigid system be employed where an internal frame prevents deformation of the envelope, the stresses due to external pressure are taken up by the framework itself, and the gas required for flotation is usually contained in several separate receptacles or ballonets similar to compartments employed in ships. In this system, therefore, we are concerned only in securing such a shape of the rigid frame as will fulfill the condition of minimum total resistance for a given displacement and velocity.

114 Once the shape of the bag is determined from the considerations already enumerated, the dimensions become immediately fixed when the tonnage is assumed, or conversely, if any linear dimension is assigned the tonnage is thereby determined.

115 In addition to the two general systems above considered, there are various types involving some of the principles of each, which are classed in general as semi-rigid systems. Such systems usually comprise a rigid frame, to which is attached the gas-bag above, and the load below.

AËRODYNAMIC ADJUSTMENTS

116 The next step is one of structural design along strictly engineering lines. The aërodynamic features of airship construction may be considered under the heads: (*a*) static balance; (*b*) dynamic balance; (*c*) stability; (*d*) natural period and oscillation.

117 *Static Balance.* The dimensions of the gas-bag being determined, the lift of each transverse segment thereof is immediately known, and the design of the frame may proceed by approximate trial and correction as in other structural work. The weight of each segment of the envelope itself is readily computed, which added to the corresponding segment of the frame gives the total weight of each segment, and this total subtracted from the lift of each segment gives the net lift for that complete segment. From the magnitude and position of these net forces the position of the resultant lift is known, and this determines the vertical line through the center of gravity. Such procedure evidently insures static balance of the machine as a whole, and an approximate distribution of the load.

118 *Dynamic Balance.* The dynamic balance must also be carefully considered; and here a difficulty has been experienced on account of the inability to place the resultant thrust coincident with the line of resistance of the ship as a whole. Heretofore, it has been customary to balance the thrust-resistance couple by means of suitable horizontal rudders or planes, so situated and at such angles, that the resultant moment of the system should be zero at uniform speeds of travel, though not necessarily zero for accelerated motion.

119 If, however, the line of thrust be made coincident with the line of resistance, the disturbing moment in question will be eliminated at uniform speeds. If, furthermore, the center of mass be located on the line of thrust and sufficiently forward to form a righting couple with the resistance when the wind suddenly veers, the evil effects of a disturbing moment will be obviated for variable as well as for constant speeds. The ship is then dynamically balanced.

120 This, of course, requires that the form of hull be such that a quartering wind shall exert a force passing to the rear of the center of mass. To illustrate, a good example of dynamic balance is found in a submarine torpedo, or a fish.

121 *Stability.* The foregoing adjustments still allow the center of mass to be placed below the center of buoyancy. This is a provision that is important in aëronautics as well as in marine architecture, indeed it is the only practical provision for keeping an even

keel and preventing heeling when the ship is at rest, or simply drifting with the wind. If the center of gravity be well below the center of buoyancy, the vessel is proportionately stable, but, of course, the stability is pendular, and may admit of considerable rolling and pitching due to shifting loads, sudden gusts of wind, etc., unless special devices be used to dampen or prevent these effects.

122 *Natural Period and Oscillations.* It may happen also that the equilibrium of the ship is disturbed by periodic forces whose periods are simply related to the natural period of the ship itself. In this case the oscillations will be cumulative and may become very large. Such effects are well known to marine engineers, and may be treated as in ordinary ship design.

AVIATION

123 This division comprises all those forms of heavier-than-air flying machines which depend for their support upon the dynamic reaction of the atmosphere. There are several subdivisions of this class dependent upon the particular principle of operation. Among these may be mentioned the aëroplane, orthopter, helicopter, etc. The only one of these that has been sufficiently developed at present to carry a man in practical flight is the aëroplane. There have been a large number of types of aëroplanes tested with more or less success and of these the following are selected for illustration.

REPRESENTATIVE AËROPLANES OF VARIOUS TYPES

THE WRIGHT BROTHERS' AËROPLANE

124 The general conditions under which the Wright machine was built for the Government were, that it should develop a speed of at least 36 miles per hour, and in its trial flights remain continuously in the air for at least 1 hour. It was designed to carry two persons having a combined weight of 350 lb. and also sufficient fuel for a flight of 125 miles. The trials at Fort Myer, Virginia, in Septe ber of 1908, indicated that the machine was able to fulfill the requirements of the government specifications.

125 The aëroplane has two superposed main surfaces 6 ft. apart with a spread of 40 ft. and a distance of 6½ ft. from front to rear. The area of this double supporting surface is about 500 sq. ft. The surfaces are so constructed that their extremities may be warped at the will of the operator.

126 A horizontal rudder of two superposed plane surfaces about

15 ft. long and 3 ft. wide is placed in front of the main surfaces. Behind the main planes is a vertical rudder formed of two surfaces trussed together about 5½ ft. long and 1 ft. wide. The auxiliary surfaces, and the mechanism controlling the warping of the main surfaces, are operated by three levers.

127 The motor, which was designed by the Wright brothers, has four cylinders and is water cooled. It develops about 25 h.p. at 1400 r.p.m. There are two wooden propellers 8½ ft. in diameter which are designed to run at about 400 r.p.m. The machine is supported on two runners, and weighs about 800 lb. A monorail is used in starting.

128 The Wright machine has attained an estimated maximum speed of about 40 miles per hour. On September 12, a few days before the accident which wrecked the machine, a record flight of 1 hour, 14 minutes, 20 seconds was made at Fort Myer, Virginia. Since that date Wilbur Wright, at Le Mans, France, has made better records; on one occasion remaining in the air for more than an hour and a half with a passenger.

129 A reference to the attached illustrations of this machine will show its details, its method of starting, and its appearance in flight.

THE HERRING AËROPLANE

130 The Signal Corps of the Army has contracted with A. M. Herring, of New York, to furnish an aëroplane under the conditions enumerated in the specification already referred to and shown in the appendix to this paper. Mr. Herring made technical delivery of his machine at the aëronautical testing ground at Fort Myer, Virginia, on October 13.

131 In compliance with the request of Mr. Herring the details of this machine will not be made public at present, but the official tests required under the contract will be conducted in public as has been the case with other aëronautical devices. Opportunity will be afforded any one to observe the machine in operation.

132 This machine embodies new features for automatic control and contains an engine of remarkable lightness per horse-power.

THE FARMAN AËROPLANE

133 The Farman flying machine has two superposed aërosurfaces 4 ft. 11 in. apart with a spread of 42 ft. 9 in. and 6 ft. 7 in. from front to rear. The total sustaining surface is about 560 sq. ft.

134 A box tail 6 ft. 7 in. wide and 9 ft. 10 in. long in rear of the main surfaces is used to balance the machine. The vertical sides of the tail are pivoted along the front edges, and serve as a vertical rudder for steering in a horizontal plane. There are two parallel, vertical partitions near the middle of the main supporting surfaces, and one vertical partition in the middle of the box tail. A horizontal rudder in front of the machine is used to elevate or depress it in flight.

135 The motor is an eight cylinder Antoinette of 50 h.p. weighing 176 lb., and developing about 38 h.p. at 1050 r.p.m.

136 The propeller is a built-up steel frame covered with aluminum sheeting, 7½ ft. in diameter, with a pitch of 4 ft. 7 in. It is mounted directly on the motor shaft immediately in rear of the middle of the main surfaces.

137 The framework is of wood, covered with canvas. A chassis steel tubing carries two pneumatic-tired bicycle wheels. Two smaller wheels are placed under the tail. The total weight of the machine is 1166 lb. The main surfaces support a little over two pounds per square foot. The machine has shown a speed of about 28 miles per hour and no starting apparatus is used.

138 On January 13, 1908, Farman won the *Grand Prix* of the Aëro Club of France in a flight of 1 minute and 28 seconds, in which he covered more than a kilometer. It is reported that on October 30, 1908, a flight of 20 miles, from Mourmelon to Rheims, was made with this machine.

THE BLERIOT AËROPLANE.

139 Following Farman's first flight from town to town, M. Bleriot with his monoplane aëroplane made a flight from Toury to the neighborhood of Artenay and back, a total distance of about 28 kilometers. He landed twice during these flights and covered 14 kilometers of his journey in about 10 minutes, or attained a speed of 52 miles an hour.

THE JUNE BUG

140 The *June Bug* was designed by the Aërial Experiment Association, of which Alexander Graham Bell is President. It has two main superposed aërosurfaces with a spread of 42 ft. and 6 in., including wing tips, with a total supporting surface of 370 sq. ft.

141 The tail is of the box type. The vertical rudder above the rear edge of the tail is 30 in. square. The horizontal rudder in front of the main surfaces is 30 in. wide by 8 ft. long. There are four

triangular wing tips pivoted along their front edges for maintaining transverse equilibrium. The vertical rudder is operated by a steering wheel, and the movable tips by cords attached to the body of the aviator.

142 The motor is a 25 h.p., 8 cylinder, air cooled, Curtiss. The single wooden propeller immediately behind the main surfaces is 6 ft. 2 in. in diameter and mounted directly on the motor shaft. It has a pitch angle of about 17 deg. and is designed to run at about 1200 r.p.m.

143 The total weight of the machine, with aviator, is 650 lb. It has a load of about $1\frac{3}{4}$ lb. per sq. ft. of supporting surface. Two pneumatic-tired bicycle wheels are attached to the lower part of the frame.

144 With this machine, Mr. G. H. Curtiss, on July 4, 1908, won the Scientific American trophy by covering the distance of over a mile in 1 minute and $42\frac{2}{5}$ seconds at a speed of about 39 miles per hour.

Some General Considerations Which Govern the Design of an Aëroplane

145 The design of an aëroplane may be considered under the heads of support, resistance and propulsion, stability and control.

146 *Support.* In this class of flying machines, since the buoyancy is practically insignificant, support must be obtained from the dynamic reaction of the atmosphere itself. In its simplest form, an aëroplane may be considered as a single plane surface moving through the air. The law of pressure on such a surface has been determined and may be expressed as follows:

$$P = 2\, k\sigma\, AV^2 \sin \alpha \tag{1}$$

in which P is the normal pressure upon the plane, k is a constant of figure, σ the density of the air, A is the area of the plane, V the relative velocity of translation of the plane through the air, and α the angle of flight.

147 This is the form taken by Duchemin's formula for small angles of flight such as are usually employed in practice. The equation shows that the upward pressure on the plane varies directly with the area of the plane, with the sine of the angle of flight, with the density of the air, and also with the square of the velocity of translation.

148 It is evident that the total upward pressure developed must be at least equal to the weight of the plane and its load, in order to support the system. If P is greater than the weight the machine will ascend, if less, it will descend.

149 The constant k depends only upon the shape and aspect of the plane, and should be determined by experiment. For example, with a plane 1 foot square $k\sigma = 0.00167$, as determined by Langley, when P is expressed in pounds per square foot, and V in feet per second.

Equation (1) may be written

$$A V^2 = \frac{P}{2 k\sigma \sin \alpha}.$$

If P and α are kept constant then the equation has the form

$$A V^2 = \text{constant}. \tag{2}$$

PRINCIPLE OF REEFING IN AVIATION

150 An interpretation of (2) reveals interesting relations between supporting area varies inversely as the square of the velocity. For example, in the Wright aëroplane, the supporting area at 40 miles per hour is 500 sq. ft., while if the speed is increased to 60 miles per hour this area need be only $\frac{500}{1.5^2} = 222$ sq. ft., or less than one-half of its present size. At 80 miles per hour the area would be reduced to 125 sq. ft., and at 100 miles per hour only 80 sq. ft. of supporting area is required. These relations are conveniently exhibited graphically.

151 It thus appears that if the angle of flight be kept constant in the Wright aëroplane, while the speed is increased to one hundred miles per hour, we may picture a machine which has a total supporting area of 80 sq. ft., or a double surface each measuring about $2\frac{1}{2}$ by 16 ft. or 4 by 10 ft. if preferred. Furthermore, the discarded mass of the 420 sq. ft. of the original supporting surface may be added to the weight of the motor and propellers in the design of a reduced aëroplane, since in this discussion the total mass is assumed constant at 1000 lb.

152 In the case of a bird's flight, its wing surface is "reefed" as its velocity is increased, which instinctive action serves to reduce its head resistance and skin-frictional area, and the consequent power required for a particular speed.

153 *Determination of k for Arched Surfaces.* Since arched surfaces are now commonly used in aëroplane construction, and as the above equation (1) applies to plane surfaces only, it is important to determine experimentally the value of the coefficient of figure k, for each type of arched surface employed, especially as k is shown in some cases to vary with the angle of flight α; i.e. the inclination of the chord of the surface to the line of translation.

154 Assuming α constant, however, we may compare the lift of any particular arched surface with a plane surface of the same projected plan and angle of flight.

155 To illustrate, in the case of the Wright aëroplane, let us assume

$$\begin{aligned} P &= 1000 \text{ lb.} = \text{total weight} = W. \\ A &= 500 \text{ sq. ft.} \\ V &= 40 \text{ miles per hour} = 60 \text{ ft. per second.} \\ \alpha &= 7 \text{ deg. approximately.} \end{aligned}$$

Whence
$$k\sigma = \frac{P}{2\,A\,V^2 \sin\alpha} = \frac{1000}{2 \times 500 \times 60^2 \times \frac{1}{8}}$$
$$= 0.0022 \ (V = \text{ft. sec.})$$
$$= 0.005 \ \ (V = \text{mi. hr.})$$

156 Comparing this value of $k\,\sigma$ with Langley's value 0.004 for a plane surface V being in miles per hour, we see that the lift for the arched surface is 25 per cent greater than for a plane surface of the same projected plan. That is to say, this arched surface is dynamically equivalent to a plane surface of 25 per cent greater area than the projected plan. Such a plane surface may be defined as the "equivalent plane."

157 *Resistance and Propulsion.* The resistance of the air to the motion of an aëroplane is composed of two parts: (a), the resistance due to the framing and load; (b), the necessary resistance of the sustaining surfaces, that is, the drift, or horizontal component of pressure; and the unavoidable skin-friction. Disregarding the frame, and considering the aëroplane as a simple plane surface, we may express the resistance by the equation

$$R = W \tan \alpha + 2\,f\,A \tag{3}$$

in which R is the total resistance, W the gross weight sustained, α the angle of flight, f the friction per square unit of area of the plane,

A the area of the plane. The first term of the second member gives the drift, the second term the skin-friction. The power required to propel the aëroplane is

$$H = R\ V$$

in which H is the power, V the velocity.

158 Now W varies as the second power of the velocity, as shown by equation (1), and f varies as the power 1.85, as will be shown later. Hence we conclude that the total resistance R of the air to the aëroplane varies approximately as the square of its speed, and the propulsive power practically as the cube of speed.

159 *Most Advantageous Speed and Angle of Flight.* Again, regarding W and A as constant, we may, by equation (1), compute α for various values of V, and find f for those velocities from the skin-friction table to be given presently. Thus α, R, and H may be found for various velocities of flight, and their magnitudes compared. In this way the values in Table 1 were computed for a soaring plane 1 ft. square weighing 1 lb., assuming $k\ \sigma = 0.004$, which is approximately Langley's value when V is in miles per hour.

COMPUTED POWER REQUIRED TO TOW A PLANE ONE FOOT SQUARE, WEIGHING ONE POUND, HORIZONTALLY THROUGH THE AIR AT VARIOUS SPEEDS AND ANGLES OF FLIGHT

Velocity	Angle of Flight	Computed Resistance			Tow-line power	Lift per tow-line h.p.
		Drift	Friction	Total		
Mi. hr.	*Deg.*	*Lb.*	*Lb.*	*Lb.*	*Ft. lb. sec.*	*Lb.*
30	8.25	0.145	0.0170	0.162	7.13	77.1
35	5.94	0.104	0.0226	0.1266	6.51	84.3
40	4.52	0.790	0.0289	0.1079	6.32	86.7
45	3.55	0.0621	0.0360	0.0981	6.39	86.1
50	2.88	0.0500	0.0439	0.0939	6.89	80.2
60	2.03	0.0354	0.0614	0.0962	8.50	64.7
70	1.47	0.0257	0.0814	0.1071	11.00	50.0
80	1.12	0.0195	0.1045	0.1240	14.56	35.8
90	0.88	0.0154	0.1300	0.1454	19.17	28.7
100	0.71	0.0124	0.1584	0.1708	25.00	22.0

160 Column two, giving values of α for various speeds is computed from equation (1). Thus at 30 miles per hour,

$$\sin \alpha = \frac{W}{2\,k\,\sigma\,A V^2} = \frac{1}{2 \times .004 \times 1 \times 30^2}$$

whence $\alpha = 8.25$ deg.

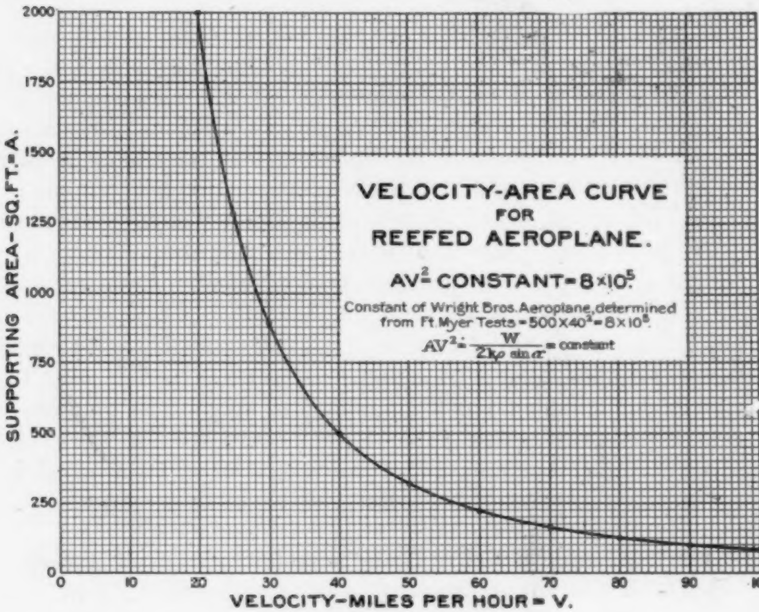

FIGURE A

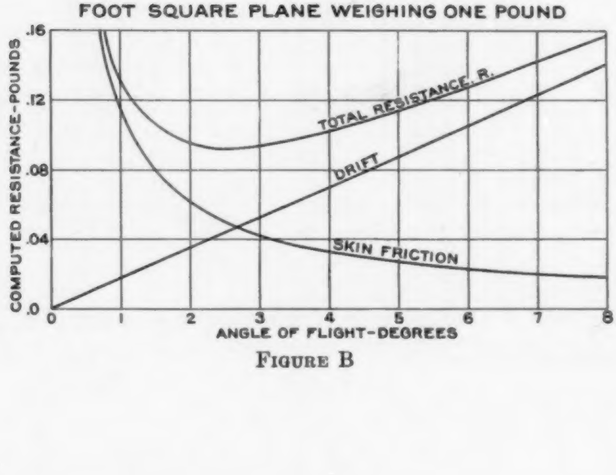

FIGURE B

161 Column three is computed from the term W tan α in equation (3), thus

$$\text{Drift} = W \tan \alpha = 1 \times \tan 8.25 \text{ deg.} = 0.145.$$

162 Column four is computed from the term $2fH$, in equation (3), f being taken from the skin-friction table to be given presently.

163 The table shows that if a thin plane 1 ft. square, weighing 1 lb. be towed through the air so as just to float horizontally at various velocities and angles of flight, the total resistance becomes a minimum at an angle of slightly less than 3 deg., and at a velocity of about 50 miles per hour; also that the skin-friction approximately equals the drift at this angle. The table also shows that the propulsive power for the given plane is a minimum at a speed of between 40 and 45 miles per hour, the angle of flight then being approximately 4.5 deg.

164 The last column of the table shows that the maximum weight carried per horse-power is less than 90 lb. This horse-load may be increased by changing the foot square plane to a rectangular plane and towing it long-side foremost; also by lightening the load, and letting the plane glide at a lower speed; but best of all, perhaps, by arching it like a vulture's wing and also towing it long-side foremost as is the prevailing practice with aëroplanes.

These relations are exhibited graphically in the diagrams, Figs. B, C and D.

STABILITY AND CONTROL

165 The question of stability is a serious one in aviation, especially as increased wind velocities are encountered. In machines of the aëroplane type there must be some means provided to secure fore and aft stability and also lateral stability.

166 A large number of plans have been proposed for the accomplishment of these ends, some based upon the skill of the aviator, others operated automatically, and still others employing a combination of both. At the present time no aëroplane has yet been publicly exhibited which is provided with automatic control. There is little difference of opinion as to the desirability of some form of automatic control.

167 The Wright aëroplane does not attempt to accomplish this, but depends entirely upon the skill of the aviator to secure both lateral and longitudinal equilibrium, but it is understood that a

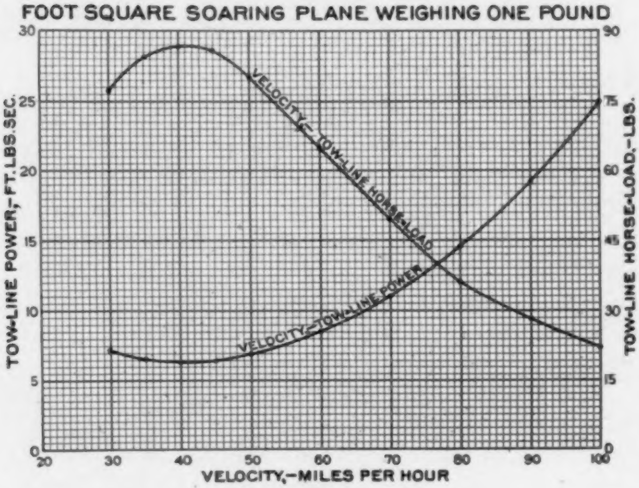

FIGURE C

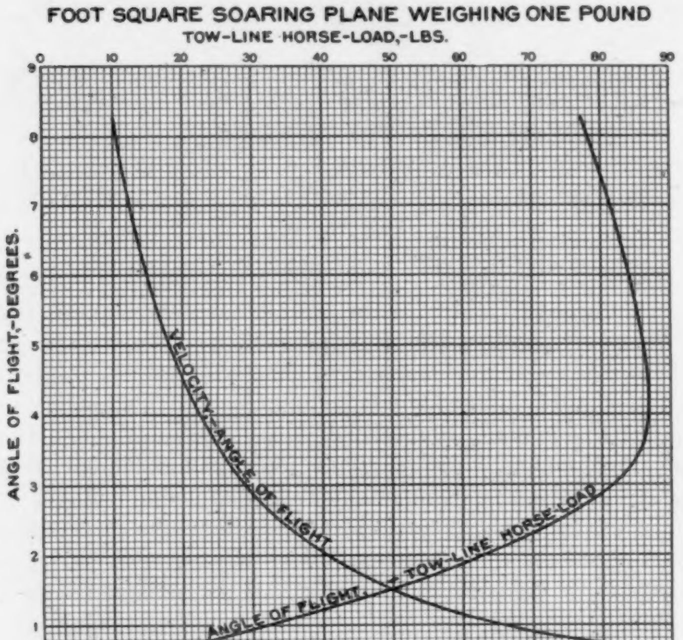

FIGURE D

device for this purpose is one of the next to be brought forward by them. Much of the success of the Wright brothers has been due to their logical procedure in the development of the aëroplane, taking the essentials, step by step, rather than attempting every thing at once, as is so often the practice with inexperienced inventors.

168 The aviator's task is much more difficult than that of the chauffeur. With the chauffeur, while it is true that it requires his constant attention to guide his machine, yet he is traveling on a roadway where he can have due warning through sight, of the turns and irregularities of the course.

169 The fundamental difference between operating the aëroplane and the automobile, is that the former is traveling along an aërial highway which has manifold humps and ridges, eddies and gusts, and since the air is invisible he cannot see these irregularities and inequalities of his path, and consequently cannot provide for them until he has actually encountered them. He must feel the road since he cannot see it.

170 Some form of automatic control whereby the machine itself promptly corrects for the inequalities of its path is evidently very desirable. As stated above, a large number of plans for doing this have been proposed, many of them based on gyrostatic action, movable side planes, revolving surfaces, warped surfaces, etc. A solution of this problem may be considered as one of the next important steps forward in the development of the aëroplane.

III. HYDROMECHANIC RELATIONS

Some General Relations Between Ships in Air and Water

171 At the present moment, so many minds are engaged upon the general problem of aërial navigation that any method by which a broad forecast of the subject can be made is particularly desirable. Each branch of the subject has its advocates, each believing implicitly in the superiority of his method. On the one hand the adherents of the dirigible balloon have little confidence in the future of the aëroplane, while another class have no energy to devote to the dirigible balloon, and still others prefer to work on the pure helicopter principle. As a matter of fact, each of these types is probably of permanent importance, and each particularly adapted to certain needs.

172 Fortunately for the development of each type, the experiments made with one class are of value to the other classes, and these

in turn bear close analogy to the types of boats used in marine navigation. The dynamical properties of water and air are very much alike, and the equations of motion are similar for the two fluids, so that the data obtained from experiments in water, which are very extensive, may with slight modification be applied to computations for aërial navigation.

173 *Helmholz' Theorem.* Von Helmholz, the master physicist of Germany, who illuminated everything he touched, has fortunately considered this subject, in a paper written in 1873. The title of his paper is "On a theorem relative to movements that are geometrically similar in fluid bodies, together with an application to the problem of steering balloons."

174 In this paper Helmholz affirms that, although the differential equations of hydro-mechanics may be an exact expression of the laws controlling the motions of fluids, still it is only for relatively few and simple experimental cases that we can obtain integrals appropriate to the given conditions, particularly if the cases involve viscosity and surfaces of discontinuity.

175 Hence, in dealing practically with the motion of fluids, we must depend upon experiment almost entirely, often being able to predict very little from theory, and that usually with uncertainty. Without integrating, however, he applies the hydrodynamic equations to transfer the observations made on any one fluid with given models and speeds, over to a geometrically similar mass of another fluid involving other speeds, and models of different magnitudes. By this means he is able to compute the size, velocity, resistance, power, etc., of aërial craft from given, or observed, values for marine craft.

176 He also deduces laws that must inevitably place a limit upon the possible size and velocity of aërial craft without, however, indicating what that limit may be with artificial power. Applying this mode of reasoning to large birds he concludes by saying that, "It therefore appears probable that in the model of the great vulture, nature has already reached the limit that can be attained with the muscles as working organs, and under the most favorable conditions of subsistence, for the magnitude of a creature that shall raise itself by its wings and remain a long time in the air."

177 In comparing the behavior of models in water and air, he takes account of the density and viscosity of the media, as these were well known at the date of his writing, 1873; but he could not take account of the sliding, or skin-friction, because in his day neither

the magnitude of such friction for air, nor the law of its variation with velocity had been determined.

SKIN-FRICTION IN AIR

178 Even as late as Langley's experiments, skin-friction in air was regarded as a negligible quantity, but due to the work of Dr. Zahm who was the first to make any really extensive and reliable experiments on skin-friction in air, we now can estimate the magnitude of this quantity. As a result of his research he has given in his paper on atmospheric friction the following equation:

$$f = 0.00000778\ l^{-0.07}\ v^{1.85} \ldots (v = \text{ft. sec.}),$$
$$f = 0.0000158\ \ l^{-0.07}\ v^{1.85} \ldots (v = \text{mi. hr.})$$

in which f is the average skin-friction per square foot, and l the length of surface.

179 From this equation the accompanying table of resistances was computed, and is inserted here for the convenience of Engineers:

TABLE 2 FRICTION PER SQUARE FOOT FOR VARIOUS SPEEDS AND LENGTHS OF SURFACE

Wind speed	Average Friction in Pounds per Square Foot					
	1 ft. plane	2 ft. plane	4 ft. plane	8 ft. plane	16 ft. plane	32 ft. plane
mi. hr.						
5	0.000303	0.000289	0.000275	0.000262	0.000250	0.000238
10	0.00112	0.00105	0.00101	0.000967	0.000922	0.000878
15	0.00237	0.00226	0.00215	0.00205	0.00195	0.00186
20	0.00402	0.00384	0.00365	0.00349	0.00332	0.00317
25	0.00606	0.00579	0.00551	0.00527	0.00501	0.00478
30	0.00850	0.00810	0.00772	0.00736	0.00701	0.00668
35	0.01130	0.0108	0.0103	0.0098	0.00932	0.00888
40	0.0145	0.0138	0.0132	0.0125	0.0125	0.0114
50	0.0219	0.0209	0.0199	0.0190	0.0181	0.0172
60	0.0307	0.0293	0.0279	0.0265	0.0253	0.0242
70	0.0407	0.0390	0.0370	0.0353	0.0337	0.0321
80	0.0522	0.0500	0.0474	0.0452	0.0431	0.0411
90	0.0650	0.0621	0.0590	0.0563	0.0536	0.0511
100	0.0792	0.0755	0.0719	0.0685	0.0652	0.0622

180 The numbers within the rules represent data coming within the range of observation. These observations show that "the frictional resistance is at least as great for air as water, in proportion to their densities. In other words, it amounts to a decided obstacle

in high speed transportation. In aëronautics it is one of the chief elements of resistance both to hull-shaped bodies and to aëro-surfaces gliding at small angles of flight."

181 *Relative Dynamic and Buoyant Support.* Peter Cooper-Hewitt has given careful study to the relative behavior of ships in air and in water. He has made a special study of hydroplanes, and has prepared graphic representations of his results which furnish a valuable forecast of the problem of flight.

182 Without knowing of Helmholz's theorem, Cooper-Hewitt has independently computed curves for ships and hydroplanes from actual data in water, and has employed these curves to solve analogous problems in air, using the relative densities of the two media, approximately 800 to 1, in order to determine the relative values of support by dynamic reaction and by displacement for various weights and speeds.

183 An analysis of these curves leadsto conclusions of importance, some of which are as follows:

184 The power consumed in propelling a displacement vessel at any constant speed, supported by air or water, is considered as being $\frac{2}{3}$ consumed by skin-resistance, or surface resistance, and $\frac{1}{3}$ consumed by head resistance. Such a vessel will be about ten diameters in length, or should be of such shape that the sum of the power consumed in surface friction and in head resistance will be a minimum (torpedo shape).

185 The power required to overcome friction due to forward movement will be about $\frac{1}{8}$ as much for a vessel in air as for a vessel of the same weight in water.

186 Leaving other things out of consideration, higher speeds can be obtained in craft of small tonnage by the dynamic reaction type than by the displacement type, for large tonnages the advantages of the displacement of type are manifest.

187 A dirigible balloon carrying the same weight, other things being equal, may be made to travel about twice as fast as a boat for the same power; or be made to travel at the same speed with the expenditure of about $\frac{1}{8}$ of the power.

188 As there are practically always currents in the air reaching at times, a velocity of many miles per hour, a dirigible balloon should be constructed with sufficient power to be able to travel at a speed of about 50 miles per hour, in order that it may be available under practical conditions of weather. In other words, it should have substantially as much power as would drive a boat, carrying the same

weight, 25 miles an hour, or should have the same ratio of power to size as the "Lusitania."

189 *Motors.* It is the general opinion that any one of several types of internal combustion motors at present available is suitable for use with dirigible balloons. With this type, lightness need not be obtained at the sacrifice of efficiency. In the aëroplane, however, lightness per output is a prime consideration, and certainty and reliability of action is demanded, since if by chance the motor stops, the machine must immediately glide to the earth. A technical discussion of motors would of itself require an extended paper, and may well form the subject of a special communication.

190 *Propellers.* The fundamental principles of propellers are the same for air as for water. In both elements, the thrust is directly proportional to the mass of fluid set in motion per second. A great variety of types of propellers have been devised, but, thus far only the screw-propeller has proved to be of practical value in air. The theory of the screw-propeller in air is substantially the same as for the deeply submerged screw-propeller in water, and therefore does not seem to call for treatment here. There is much need at present for accurate aërodynamic data on the behavior of screw-propellers in air, and it is hoped that engineers will soon secure such data, and present it in practical form for the use of those interested in airship design.

191 *Limitations.* Euclid's familiar "square-cube" theorem connecting the volumes and surfaces of similar figures, as is well known, operates in favor of increased size of dirigibles, and limits the possible size of heavier-than-air machines in single units and with concentrated load.

192 It appears, however, that both fundamental forms of aërial craft will likely be developed, and that the lighter-than-air type will be the burden-bearing machine of the future, whereas the heavier-than-air type will be limited to comparatively low tonnage, operating at relatively high velocity. The helicopter type of machine may be considered as the limit of the aëroplane, when by constantly increasing the speed, the area of the supporting surfaces is continuously reduced until it practically disappears. We may then picture a racing aëroplane propelled by great power, supported largely by the pressure against its body, and with its wings reduced to mere fins which serve to guide and steady its motion. In other words, starting with the aëroplane type; we have the dirigible balloon on the one hand as the tonnage increases, and the helicopter type on the other extreme as the speed increases. Apparently, therefore, no one of

these forms will be exclusively used, but each will have its place for the particular work required.

IV. AËRIAL LOCOMOTION IN WARFARE

193 Whatever may be the influence of aërial navigation upon the Art of War, the fact which must be considered at present is, that each of the principal Military Powers is displaying feverish activity in developing this auxiliary as an adjunct to the military establishment.

194 If each of the great Powers of the world would agree that aërial warfare should not be carried on, the subject would be of no great interest to this country as far as our military policy is concerned, but until such an agreement is made this country is forced to an immediate and serious consideration of this subject in order to be prepared for any eventuality.

195 The identical reasoning which has led to the adoption of a policy of providing for increasing our Navy year by year to maintain our relative supremacy on the sea, is immediately applicable to the military control of the air. If the policy in respect to the Navy is admitted, there is no escape from the deduction that we should proceed in the development of ships of the air on a scale commensurate with the position of the Nation.

196 The question as to whether or not the Powers will ultimately permit the use of aërial ships in war is not at present the practical one, because in case such use is authorized it will be too late adequately to equip ourselves after war has been declared.

ACTION OF THE HAGUE PEACE CONFERENCE

197 The following is the declaration signed by the delegates of the United States to the Second International Peace Conference held at The Hague, June 15 to October 19, 1907, prohibiting the discharge of projectiles and explosives from balloons, ratified March 10, 1908.

198 Declaration:

cite machiavelli

The Contracting Powers agree to prohibit, for a period extending to the close of the Third Peace Conference, the discharge of projectiles and explosives from balloons or by other new methods of a similar nature.

199 The delegates of the United States signed this declaration. The countries which did not sign the declaration forbidding the launching of projectiles and explosives from balloons were: Germany,

Austria-Hungary, China, Denmark, Ecuador, Spain, France, Great Britain, Guatemala, Italy, Japan, Mexico, Montenegro, Nicaragua, Paraguay, Roumania, Russia, Servia, Sweden, Switzerland, Turkey, Venezuela.

200 It appears that the United States is the only first-class Power who signed this agreement, and an analysis of the text of the agreement itself shows that no serious attempt was made to settle the question finally.

201 For instance, while the war balloon may not discharge projectiles or explosives from above, yet no reciprocal provision is made preventing such war balloon from being fired upon from the earth below, yet the law of self-defense evidently obtains.

202 Furthermore, Naval Experts will tell you that they fear no enemy quite as much as a submarine mine, whose location is unknown and which gives no warning when it is approached. Our own experience shows that the Battleship Maine could be completely destroyed in time of peace without any one detecting the preparations for its accomplishment.

203 If, then, a nation can submerge a mine for the destruction of ships from underneath the water, why can it not drop an aërial mine upon a ship from above? And if it should be allowed to drop an aërial mine upon an enemy's fortified ship at sea, it certainly should be allowed to drop such an aërial mine upon a fortified place on land.

INFLUENCE ON THE MILITARY ART

204 The Military Art up to the present time, has been practically conducted in a plane where the armies concerned have been limited in their movements in time and place by the physical character of the terrane. A large army, for instance cannot move faster than about 12 miles a day by marching, and the use of railroads as applied to the Art of War was first recognized in the Franco-Prussian war. By their use, the mobilization of the great Prussian army, and its accurate assembling in the theater of operations within ten days, contributed an initial advantage not before possible.

205 The very essence of strategy is surprise, and there never were better opportunities than at present for a constructive General to achieve great victories. But these victories to be really great, must be founded upon some new development or use of power not heretofore known in war. They must also tend to produce results with the minimum loss of human life. In other words, the sentiment of

the world demands that the Military Art shall always aim to capture, not destroy.

206 It may be said, that the consummation of Military Art is found in maneuvering the enemy into untenable situations, thereby forcing a decisive result with a minimum loss of life and treasure.

207 As to the technical use of dirigible balloons and aëroplanes in warfare we have nothing but theory at present to guide us. It would appear, however, in the case of dirigible balloons that two different classes of such ships should be developed.

208 First: A comparatively small dirigible type with a capacity of from 50 000 to 100 000 cubic feet, to be used principally for scouting purposes and to a limited extent for carrying explosives for demolitions or for incendiary purposes, such as destroying bridges and supply depots close to the mobile army or coast defense fortress. In reconnoitering dirigibles of this class, in order to be safe during day-time they will have to maneuver at an altitude of about a mile, but experiments show that telephotographic apparatus will operate from this height to give much detail.

209 At night, such dirigibles may descend to within a few hundred feet of the ground with safety and thus obtain much valuable information. Equipped with wireless telegraph or telephone apparatus, military data could be obtained and transmitted without undue risk. Due to the small carrying capacity of such sizes, the radius of action would probably be limited at present to about two hundred miles.

210 Second: This type of dirigible may be developed for burden-bearing purposes. It has been pointed out above that the larger the airship the greater the speed it may be given, and the greater its radius of action. There is no reason to doubt, that airships of capacity, from 500 000 to 1 000 000 cubic feet may be ultimately developed to attain speeds of 50 to 75 miles per hour. With a capacity for such speed, the aërial craft becomes a powerful practical engine of war which may be used in all ordinary weather. By keeping high in the air in day-time, and descending at night, they may launch high explosives, producing great damage. Being able to pass over armies and proceed at great speeds, their objectives would not usually be the enemy's armies, but their efforts would be directed against his base of supplies; to destroy his dry-docks, arsenals, ammunition depots, principal railway centers, storehouses, and indeed the enemy's Navy itself.

211 It is thought that there will be little difficulty in launching explosives with accuracy, provided good maps and plans are available. Due to the small cost of such ships as compared with naval vessels, the risk of loss would be readily taken.

212 The element of time has always been a controlling factor in warfare. It is often a military necessity to conduct a reconnoissance in force to develop the enemy's dispositions. This requires at times a detachment of several thousand men from the main army, for a considerable period of time to accomplish this end. With efficient military airships, these results may be attained with a very few men in a small fraction of the time heretofore required.

213 *Delimitation of Frontiers.* The realization of aërial navigation for military purposes, brings forward new questions regarding the limitation of frontiers. As long as military operations are confined to the surface of the earth, it has been the custom to protect the geographical limits of a country by ample preparations in time of peace, such as a line of fortresses properly garrisoned. At the outbreak of war these boundaries represent real and definite limits to military operations. Excursions into the enemy's territory usually require the backing of a strong military force. Under the new conditions, however, these geographic boundaries no longer offer the same definite limits to military movements. With a third dimension added to the theater of operations, it will be possible to pass over this boundary on rapid raids for obtaining information, accomplishing demolitions, etc., returning to safe harbors in a minimum time. We may, therefore, regard the advent of military ships of the air, as, in a measure, obliterating present national frontiers in conducting military operations.

214 One of the military objectives in warfare, is usually the enemy's capital city, his ministers, and his chief Executive. This objective has heretofore been protected by large armies of soldiers, who, in themselves are not so important to the result. In order to attain the objective, it has been frequently necessary to subdue large numbers of soldiers needlessly.

215 With the advent of efficient ships of the air, however, small parties may pass over these protective armies on expeditions aimed at the seat of government itself, where reside the body of particular individuals most responsible, so that the ultimate result will be to deter a rash entrance into war for personal ends; since now for the first time responsible individuals of state may be in immediate and personal danger after the declaration of war, which heretofore has not been usually the case.

INTERIOR HARBORS

216 In the development of these larger types of dirigible balloons the main difficulty will be, in providing suitable harbors or places of safety, for replenishing supplies and for seeking shelter in times of stress. As long as the dirigible balloon remains in the air it may be regarded as tolerably safe, both in itself, and as a conveyance for observers. If its engines are disabled, it is at least a free balloon and may be operated as such.

217 When brought in contact with the ground, however, it is in considerable danger from high winds. The momentum of such an enormous airship is great, and the comparatively fragile structure of the craft makes it an easy prey to the pounding which it is likely to receive when landing. Just as marine ships must seek a sheltered harbor or put to the open sea in times of storm, so in case of ships of the air, it is much more necessary either to brave the storm in the open, or to seek some sheltered harbor on land.

218 Fortunately, in this case, certain suitable harbors for very large ships may be provided at small expense, by using narrow and deep valleys and ravines, surrounded by forests or other protection, or prepared railway cuts, etc., where the airship may descend and be reasonably safe from the winds above. These harbors should, of course, be known to the pilot, and carefully plotted on his maps beforehand. The compass bearings of each harbor from prominent points on land must be known and plotted, to assist as far as possible in navigating the airship in thick weather; and such harbors may be indicated to the pilot at night by vertical searchlight beams, or by suitable rockets, etc.

219 The aëroplane, as has been pointed out, is likely to prove a flying machine of comparatively low tonnage and high speed. It is not likely to become a burden-bearing ship, at least in single units, but will be extremely useful for reconnoitering purposes; for dispatching important orders and instructions at high speed; for reaching inaccessible points; or for carrying individuals of high rank and command to points where their personality is needed.

220 One of the bloodiest contests the world has ever seen, was the Japanese attack on "203 Meter Hill," yet, the sole object of this great slaughter, was for the purpose of placing two or three men at its summit to direct the fire of the Japanese siege guns upon the Russian fleet in the harbor at Port Arthur.

221 If the United States had possessed in 1898, a single dirigible

balloon, even of the size of the one now at Fort Myer, Virginia, which cost less than $10 000, the American Army and Navy would not have long remained in doubt of the presence of Cervera's fleet in Santiago Harbor.

222 The world is undoubtedly growing more humane year by year. We have arrived at a conception of the principle of an efficient Army and Navy, not to provoke war but to preserve peace, and it is believed, that, following this principle, the perfection of ships of the air for military purposes will materially contribute, on the whole, to make war less likely in the future than in the past.

APPENDIX NO. 1

SIGNAL CORPS SPECIFICATION, NO. 486

Advertisement and Specification for a Heavier-than-Air Flying Machine.

To the Public:

Sealed proposals, in duplicate, will be received at this office until 12 o'clock noon on February 1, 1908, on behalf of the Board of Ordnance and Fortification for furnishing the Signal Corps with a heavier-than-air flying machine. All proposals received will be turned over to the Board of Ordnance and Fortification at its first meeting after February 1 for its official action.

Persons wishing to submit proposals under this specification can obtain the necessary forms and envelopes by application to the Chief Signal Officer, United States Army, War Department, Washington, D. C. The United States reserves the right to reject any and all proposals.

Unless the bidders are also the manufacturers of the flying machine they must state the name and place of the maker.

Preliminary.—This specification covers the construction of a flying machine supported entirely by the dynamic reaction of the atmosphere and having no gas bag.

Acceptance.—The flying machine will be accepted only after a successful trial flight, during which it will comply with all requirements of this specification. No payments on account will be made until after the trial flight and acceptance.

Inspection.—The Government reserves the right to inspect any and all processes of manufacture.

GENERAL REQUIREMENTS.

The general dimensions of the flying machine will be determined by the manufacturer, subject to the following conditions:

1. Bidders must submit with their proposals the following:
   - (*a*) Drawings to scale showing the general dimensions and shape of the flying machine which they propose to build under this specification.
   - (*b*) Statement of the speed for which it is designed.
   - (*c*) Statement of the total surface area of the supporting planes.
   - (*d*) Statement of the total weight.
   - (*e*) Description of the engine which will be used for motive power.
   - (*f*) The material of which the frame, planes, and propellers will be constructed. Plans received will not be shown to other bidders.

2. It is desirable that the flying machine should be designed so that it may be quickly and easily assembled and taken apart and packed for transportation in army wagons. It should be capable of being assembled and put in operating condition in about one hour.

3. The flying machine must be designed to carry two persons having a combined weight of about 350 pounds, also sufficient fuel for a flight of 125 miles.

4. The flying machine should be designed to have a speed of at least forty miles per hour in still air, but bidders must submit quotations in their proposals for cost depending upon the speed attained during the trial flight, according to the following scale:

40 miles per hour, 100 per cent.
39 miles per hour, 90 per cent.
38 miles per hour, 80 per cent.
37 miles per hour, 70 per cent.
36 miles per hour, 60 per cent.
Less than 36 miles per hour rejected.
41 miles per hour, 110 per cent.
42 miles per hour, 120 per cent.
43 miles per hour, 130 per cent.
44 miles per hour, 140 per cent.

5. The speed accomplished during the trial flight will be determined by taking an average of the time over a measured course of more than five miles, against and with the wind. The time will be taken by a flying start, passing the starting point at full speed at both ends of the course. This test subject to such additional details as the Chief Signal Officer of the Army may prescribe at the time.

6. Before acceptance a trial endurance flight will be required of at least one hour during which time the flying machine must remain continuously in the air without landing. It shall return to the starting point and land without any damage that would prevent it immediately starting upon another flight. During this trial flight of one hour it must be steered in all directions without difficulty and at all times under perfect control and equilibrium.

7. Three trials will be allowed for speed as provided for in paragraphs 4 and 5. Three trials for endurance as provided for in paragraph 6, and both tests must be completed within a period of thirty days from the date of delivery. The expense of the tests to be borne by the manufacturer. The place of delivery to the Government and trial flights will be at Fort Myer, Virginia.

8. It should be so designed as to ascend in any country which may be encountered in field service. The starting device must be simple and transportable. It should also land in a field without requiring a specially prepared spot and without damaging its structure.

9. It should be provided with some device to permit of a safe descent in case of an accident to the propelling machinery.

10. It should be sufficiently simple in its construction and operation to permit an intelligent man to become proficient in its use within a reasonable length of time.

11. Bidders must furnish evidence that the Government of the United States has the lawful right to use all patented devices or appurtenances which may be a part of the flying machine, and that the manufacturers of the flying machine are authorized to convey the same to the Government. This refers to the unrestricted right to use the flying machine sold to the Government, but does not contemplate the exclusive purchase of patent rights for duplicating the flying machine.

12. Bidders will be required to furnish with their proposal a certified check amounting to ten per cent of the price stated for the 40-mile speed. Upon making the award for this flying machine these certified checks will be returned to the bidders, and the successful bidder will be required to furnish a bond, according to Army Regulations, of the amount equal to the price stated for the 40-mile speed.

13. The price quoted in proposals must be understood to include the instruction of two men in the handling and operation of this flying machine. No extra charge for this service will be allowed.

14. Bidders must state the time which will be required for delivery after receipt of order.

JAMES ALLEN
Brigadier General, Chief Signal Officer of the Army

SIGNAL OFFICE,
Washington, D. C., December 23, 1907

APPENDIX NO. 2

SIGNAL CORPS SPECIFICATION, NO. 483.

ADVERTISEMENT AND SPECIFICATION FOR A DIRIGIBLE BALLOON.

Bidders are requested to read carefully every paragraph of this specification and include in their proposal every detail called for.

To the public.—Sealed proposals, in duplicate, will be received at this office until 12 o'clock noon on February 15, 1908, and no proposals will be considered which are received after that hour.

Persons wishing to submit proposals under this specification can obtain the necessary forms and envelopes by application to the Chief Signal Officer, United States Army, War Department, Washington, D.C. The United States reserves the right to reject any and all proposals.

Unless the bidders are also the manufacturers of the dirigible balloon they must state the name and place of the maker.

Preliminary.—This specification covers the construction of a dirigible balloon, to consist of a gas bag supporting a suitable framework on which will be mounted the necessary propelling machinery.

Inspection.—The Chief Signal Officer of the Army will reserve the right to inspect any and all processes of manufacture, and unsatisfactory material will be marked for rejection by the inspectors before assembling.

Acceptance.—The dirigible balloon will be accepted only after a trial flight, during which it will comply with all requirements of this specification.

GENERAL REQUIREMENTS.

The general dimensions of the dirigible balloon will be determined by the manufacturer, subject to the following conditions:

1. The gas bag shall be designed for inflation with hydrogen. The material for the gas bag shall be furnished by the bidder, and shall be subject to approval by the Chief Signal Officer of the Army, and must have a minimum breaking strength of not less than 62½ pounds per inch width and must require no varnish. The dimensions and shape of the gas bag will be as desired by the manufacturer, except that the length must not exceed one hundred and twenty (120) feet.

2. Inside the gas bag there will be either one or two ballonets having a total capacity of at least one-sixth the total volume of the gas bag. Leading to the ballonets there will be tubes of proper size connected to a suitable centrifugal blower for maintaining a constant air pressure in the ballonets. The approved fabric for the ballonets must have a minimum tensile strength of not less than 48½ pounds per inch width.

3. *Valves.*—In the lower part of the ballonet and gas bag, or on the ballonet air tubes near the gas bag, there will be an adjustable automatic valve designed

to release air from the ballonet to the outside atmosphere. On the under side of the gas bag there will be a second adjustable automatic valve of suitable size, so designed as to release hydrogen from the interior of the gas bag to the outside atmosphere. This valve will also be arranged so that it may be opened at will by the pilot.

4. In the upper portion of the gas bag there will be provided a ripping strip covering an opening five (5) inches wide by six (6) feet long, with a red rip cord attached in the usual manner and brought down within reach of the pilot through a suitable gas-tight rubber plug inserted in a wooden ring socket.

5. The suspension system and frame must be designed to have a factor of safety of at least three, taking into account wind strains as well as the weight suspended.

6. A type of frame which can be quickly and easily assembled and taken apart will be considered an advantage.

7. The balloon must be designed to carry two persons having a combined weight of 350 pounds; also at least 100 pounds of ballast, which may be used to compensate for increased weight of balloon when operating in rain.

8. The dirigible balloon should be designed to have a speed of twenty miles per hour in still air, but bidders must submit quotations in their proposals for cost depending upon the speed attained during the trial flight acording to the following schedule:

20 miles per hour, 100 per cent.
19 miles per hour, 85 per cent.
18 miles per hour, 70 per cent.
17 miles per hour, 55 per cent.
16 miles per hour, 40 per cent.
Less than 16 miles per hour rejected.
21 miles per hour, 115 per cent.
22 miles per hour, 130 per cent.
23 miles per hour, 145 per cent.
24 miles per hour, 160 per cent.

9. The speed accomplished during the trial flight will be determined by taking an average of the time over a measured course of between two and five miles against and with the wind. The time will be taken by a flying start, passing the starting point at full speed at both ends of the course. This test subject to such additional details as the Chief Signal Officer of the Army may prescribe at the time.

10. Provision must be made to carry sufficient fuel for continuous operation of the engine for at least two hours. This will be determined by a trial endurance flight of two hours, during which time the airship will travel continuously at an average speed of at least 70 per cent of that which the airship accomplishes during the trial flight for speed stated in paragraph 9 of this specification. The engine must have suitable cooling arrangements, so that excessive heating will not occur.

11. Three trials will be allowed for speed as provided for in paragraph 9, and three trials for endurance as provided for in paragraph 10, and both tests must be completed within a period of thirty days from the date of delivery, the expense of the tests to be borne by the manufacturer. The place of delivery to the Government and trial flights will be at Fort Myer, Virginia.

12. The scheme for ascending and descending and maintaining equilibrium must be regulated by shifting weights, movable planes, using two ballonets or other approved method. Balancing by the aëronaut changing his position will not be accepted.

13. This dirigible balloon will be provided with a rudder of suitable size, a manometer for indicating the pressure within the gas bag, and all other fittings and appurtenances which will be required for successful and continuous flights, according to this specification.

14. Bidders will be required to furnish with their proposal a certified check amounting to fifteen per cent of the price stated for the 20-mile speed. Upon making the award for this airship these certified checks will be returned to bidders, and the successful bidder will be required to furnish a bond, according to Army Regulations, of the amount equal to the price stated for 20-mile speed.

15. Bidders must submit with their proposals drawings to scale showing the general dimensions and shape of the dirigible balloon which they propose to build under this specification; the horsepower and description of the engine which will be used for the motive power; the size, pitch and number of revolutions of the propellers; drawing illustrating the suspension system for attaching frame to gas bag; horse power and description of blower for forcing air into ballonets; volume of gas bag; volume of ballonets; the material of which the frame will be constructed; size of valves, etc. Plans received will not be shown to other bidders.

16. Bidders must furnish evidence that the Government of the United States has the lawful right to use all patented devices or appurtenances which may be part of the dirigible balloon and that the manufacturers of the dirigible balloon are authorized to convey the same to the Government. This refers to the right of the Government to use this dirigible balloon without liability for infringement of other inventors' patents. It does not contemplate the exclusive purchase of patent rights for duplicating the airship.

17. The prices quoted in proposals must be understood to include the instruction of two men in the handling and operation of this airship. No extra charge for this service will be allowed.

JAMES ALLEN
Brigadier General, Chief Signal Officer of the Army

SIGNAL OFFICE
Washington, D. C., January 21, 1908

APPENDIX NO. 3

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Illustrierte Aeronautische Mitteilungen, Berlin
Weiner Luftschiffer-Zeitung, Vienna
Illustrierte Mittheilungen des Obenheinische Verein für Luftschiffahrt, Strassburg
Bollettino della Societa Aeronautica, Rome
Vozdobkhoplavatel, St. Petersburg

AËRONAUTICAL SOCIETIES OF THE WORLD

INTERNATIONAL SCIENTIFIC SOCIETIES

The International Commission for Scientific Aëronautics, Paris
The Permanent International Aëronautical Committee, Paris
Federation Aeronautique Internationale, Paris

NATIONAL SOCIETIES (Germany)

Deutscher Luftschiffer-Verband, Augsburg
Berliner Verein fur Luftschiffahrt, Berlin
Münchener Verein fur Luftschiffahrt, Munich
Oberrheinischer Verein fur Luftschiffahrt, Strassbourg
Augsburger Verein fur Luftschiffahrt, Augsburg
Niederrheinischer Verein fur Luftschiffahrt, Barmen
Posener Verein fur Luftschiffahrt, Posen
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Frankischer Verein fur Luftschiffahrt, Wurzburg
Mittelrheinischer Verein fur Luftschiffahrt, Coblenz
Kolner Klub fur Luftschiffahrt, Kallenburg
Physikalischer Verein im Frankfort, Frankfort
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SOCIETIES OF OTHER NATIONS.

Wiener Flugtechnischer Verein, Vienna
Wiener Aëro Club, Vienna
Aëro Club Suisse, Berne
Aëronautical Society of Great Britain, London
Aëro Club of the United Kingdom, London

Aëro Club of America, New York
Aëro Club of New England, Boston
Aëro Club of Philadelphia, Philadelphia
The Philadelphia Aëronautical Recreation Society,Philadelphia
Aëro Club of Ohio, Canton, Ohio
Aëro Club of St. Louis, St. Louis
Milwaukee Aëro Club, Milwaukee
Ben Franklin Aëronautical Society, Philadelphia
North Adams Aëro Club, North Adams, Mass.
Pittsfield Aëro Club, Pittsfield, Mass.
The Aëronautical Society, New York
Aëro Club of Chicago, Chicago
Aëronautique Club of Chicago, Chicago
Aëro Club of San Antonio, San Antonio, Texas
Svenska Aëronautiska Sallskapet, Stockholm
Société Francais de Navigation Aerienne, Paris
Aëronautique Club de France, Paris and Lyons
Aëro Club de France, Paris
Academie Aëronautique de France, Paris
Société des Aëronautes du Siege, Paris
Aëro Club du Sud-Ouest, Bordeaux
Aëro Club du Rhone, Lyon
Aëro Club du Nord, Roubaix
Club Aeronautique de l'Aube, Troye
Automobile Club de Nice, Nice
Aëro Club de Belgique, Brussels
Societa Aeronautica Italiana, Rome
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El Real Aëro-Club de Espana, Madrid

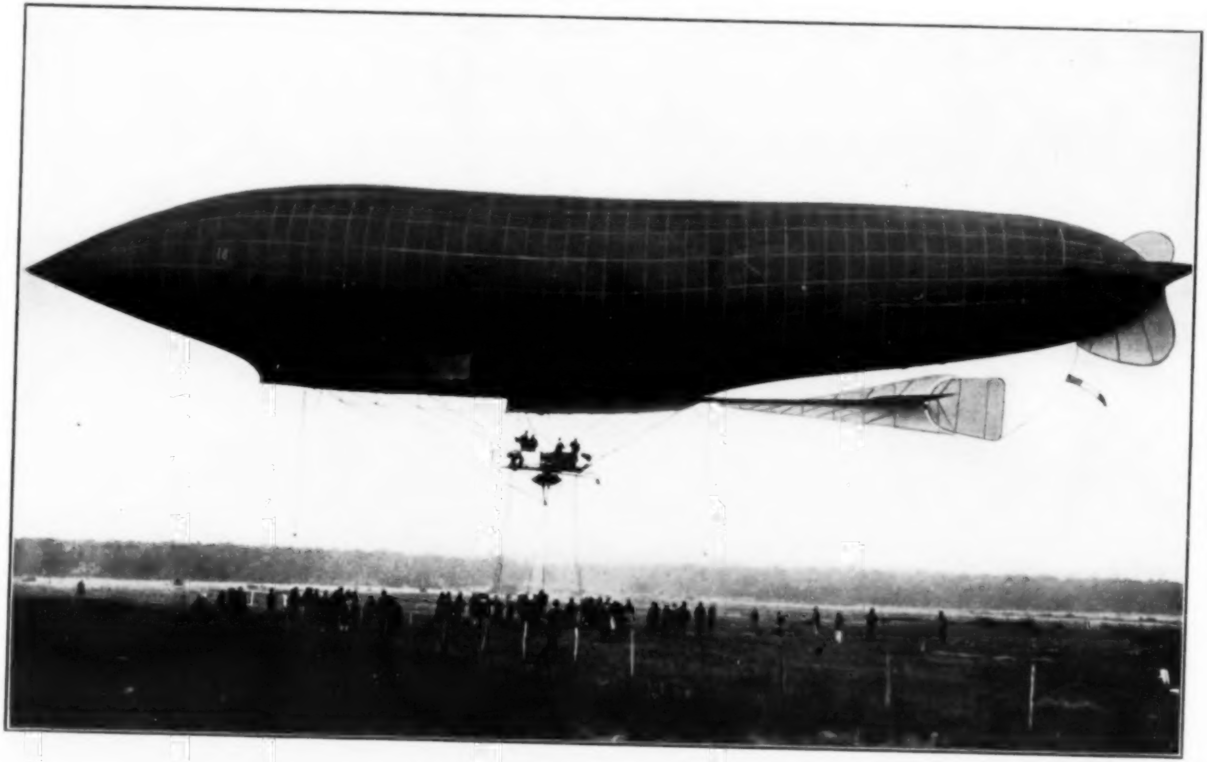

Fig. 1 French Dirigible "Patrie"

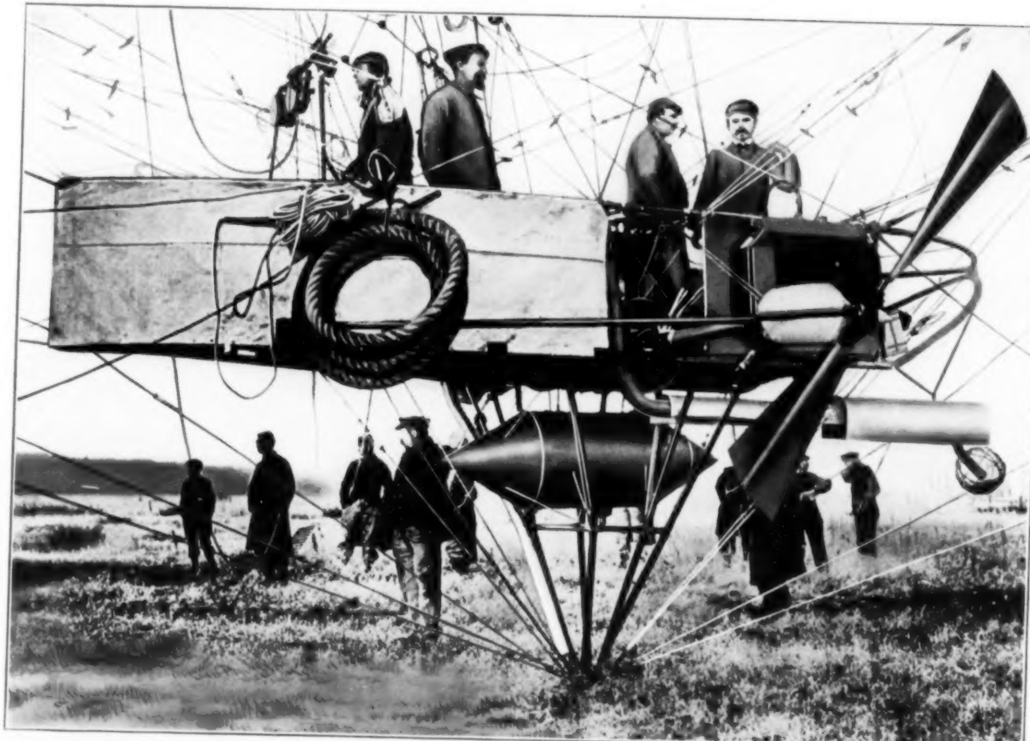

Fig. 2 French Dirigible "Patrie;" Details of Car

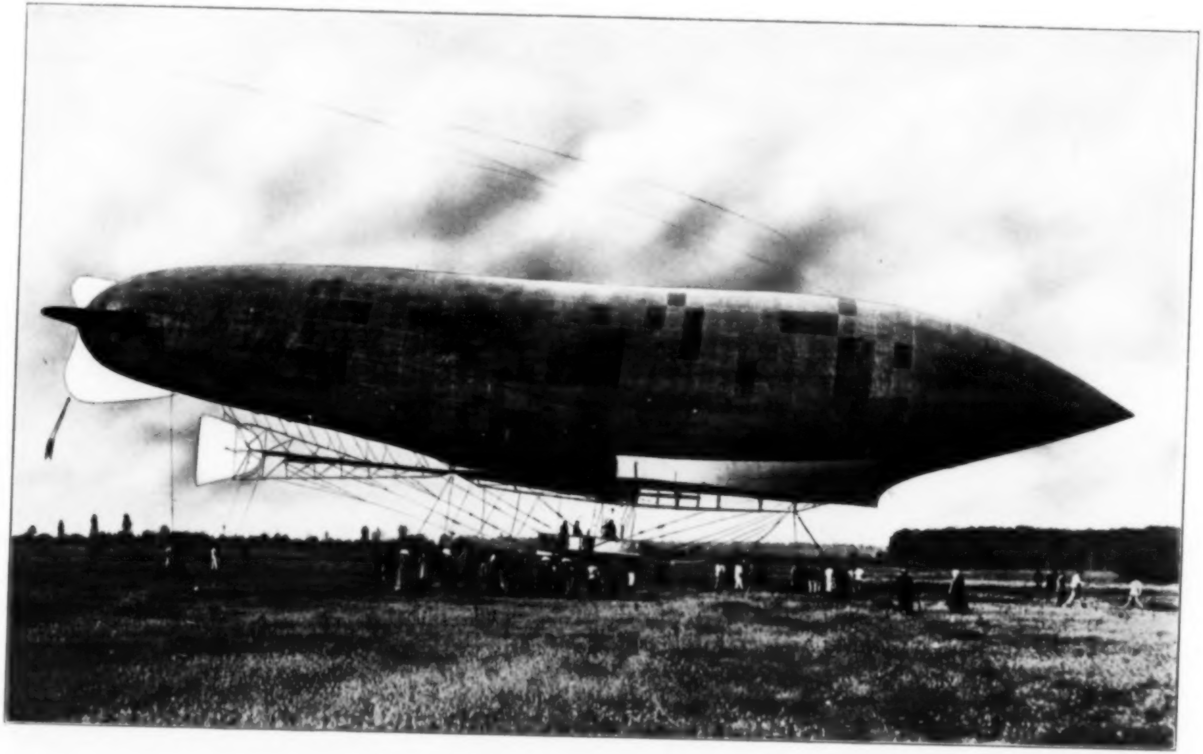

FIG. 3 FRENCH DIRIGIBLE "REPUBLIQUE"

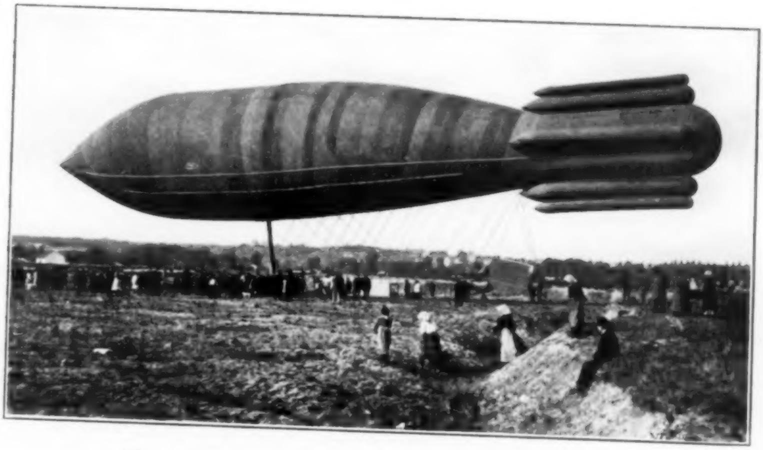

FIG. 4 FRENCH DIRIGIBLE "LA VILLE DE PARIS"

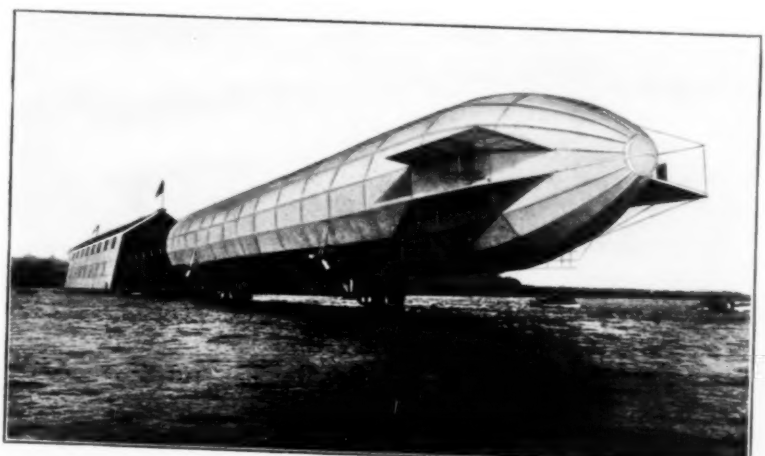

FIG. 6 GERMAN DIRIGIBLE "ZEPPELIN" WITH FLOATING HANGAR

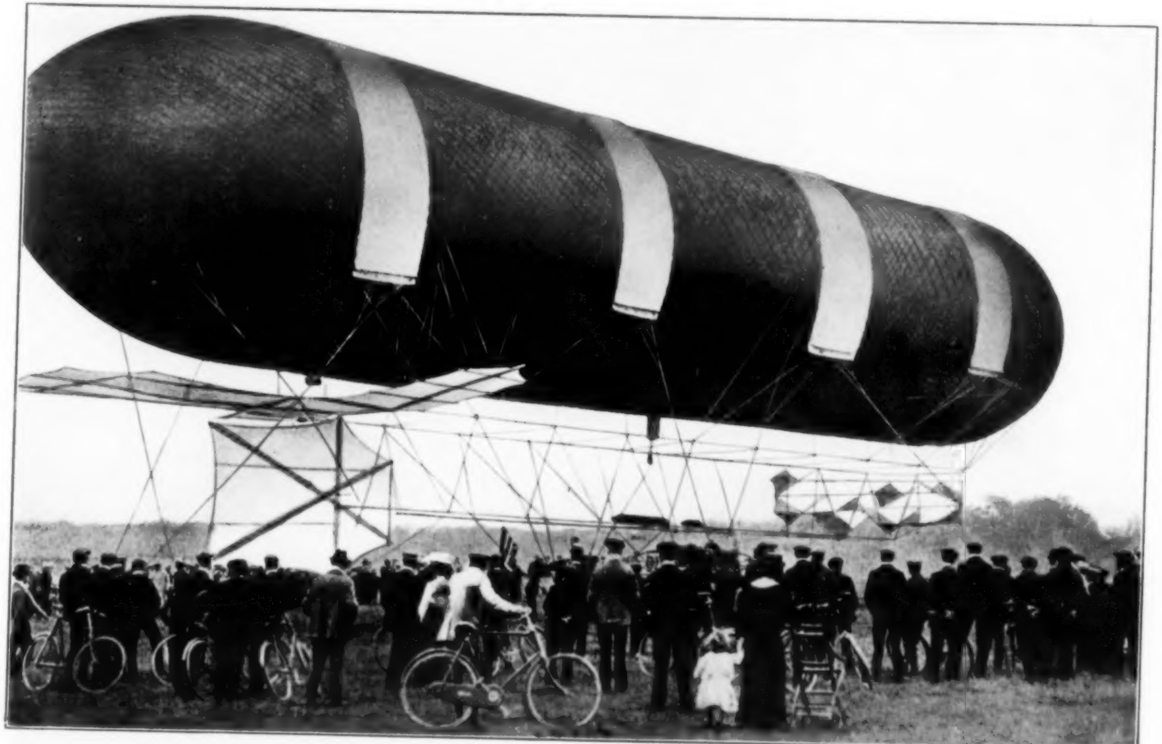

Fig. 5 English Dirigible No. 1

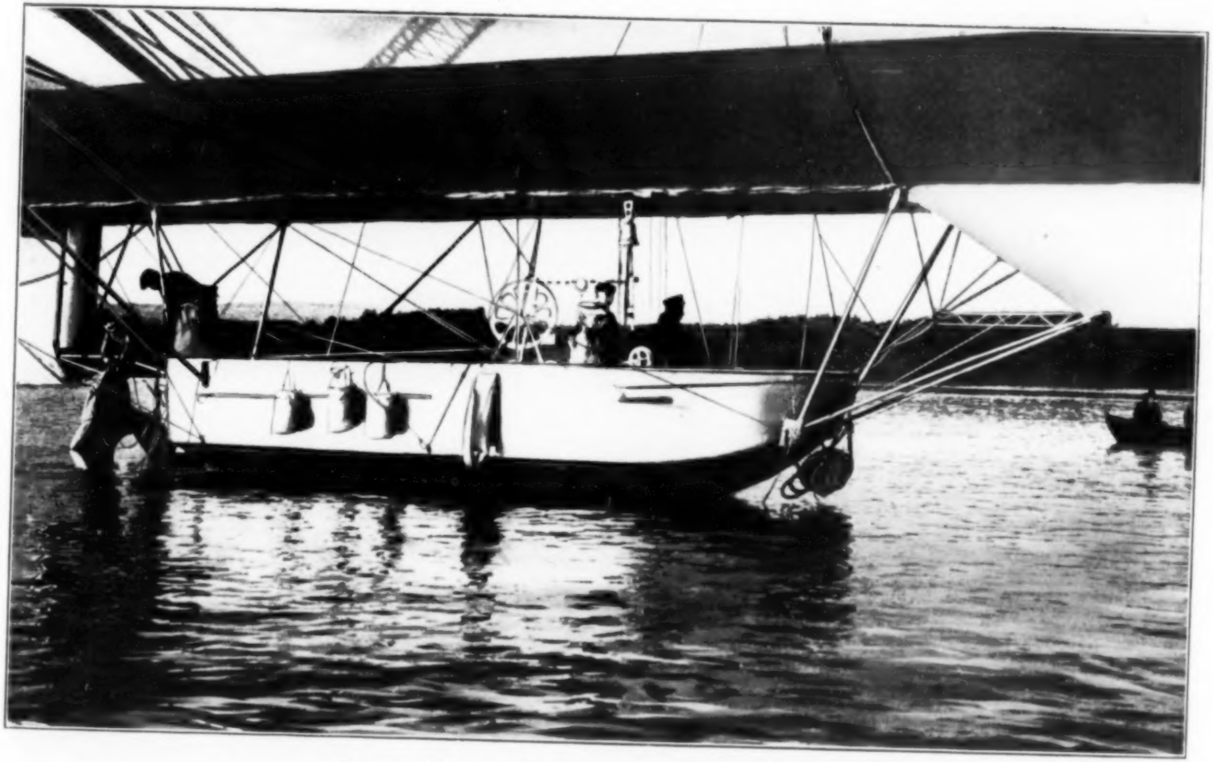

FIG. 7 GERMAN DIRIGIBLE "ZEPPELIN;" DETAILS OF CAR

FIG. 8 SIGNAL CORPS DIRIGIBLE NO. 1, IN FLIGHT, FORT MYER, VA., AUGUST, 1908

FIG. 9 SIGNAL CORPS DIRIGIBLE NO. 1, IN FLIGHT. FORT MYER, VA., AUGUST, 1908

FIG. 10 SIGNAL CORPS DIRIGIBLE NO. 1, SHOWING DETAILS OF FRONT MANŒUVERING PLANES

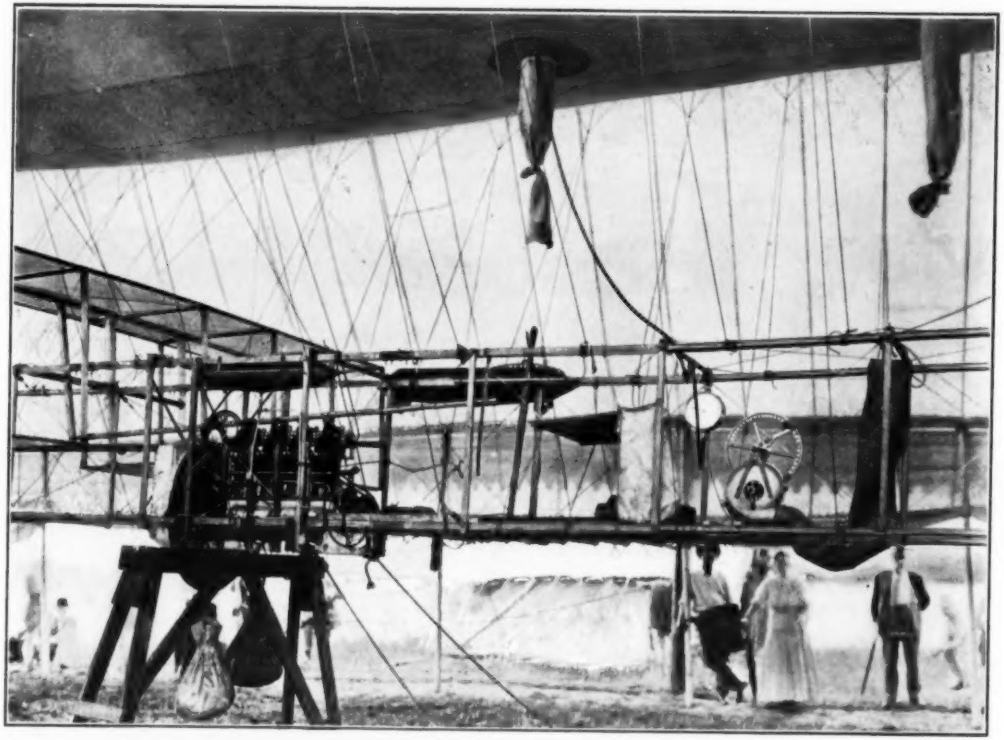

Fig. 11 Signal Corps Dirigible No. 1, Showing Details of Car

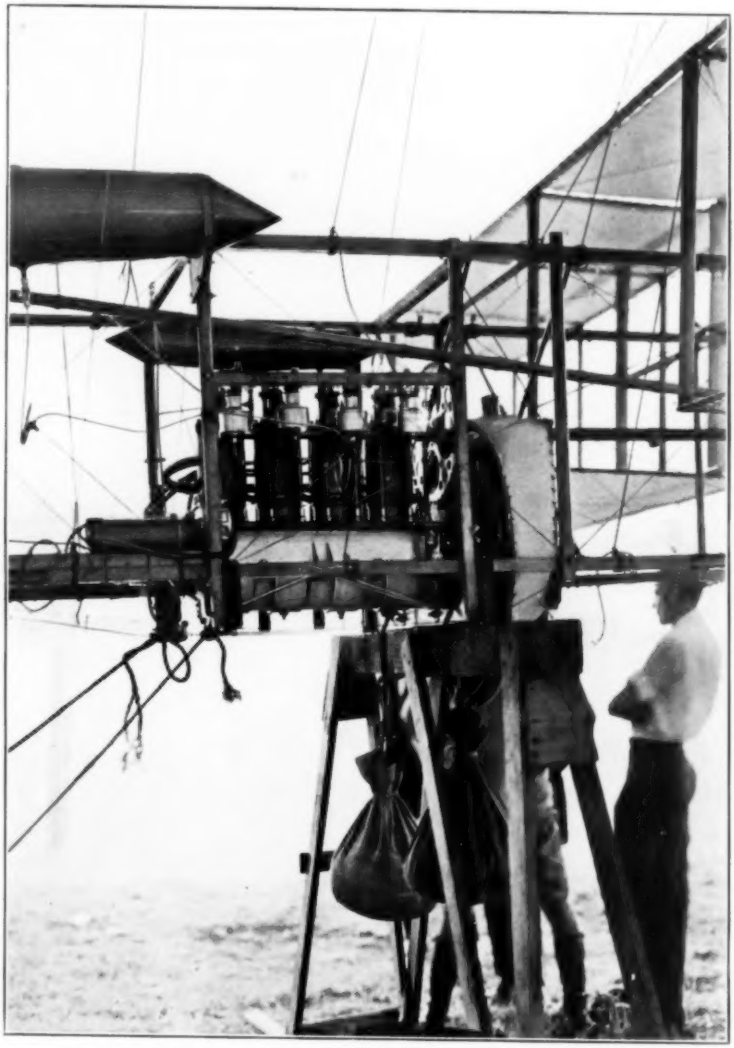

FIG. 12 SIGNAL CORPS DIRIGIBLE NO. 1, SHOWING DETAILS OF ENGINE

FIG. 13 STEEL BALLOON HOUSE, GASOMETER AND HYDROGEN GENERATING PLANT, SIGNAL CORPS POST, FORT OMAHA, NEBRASKA

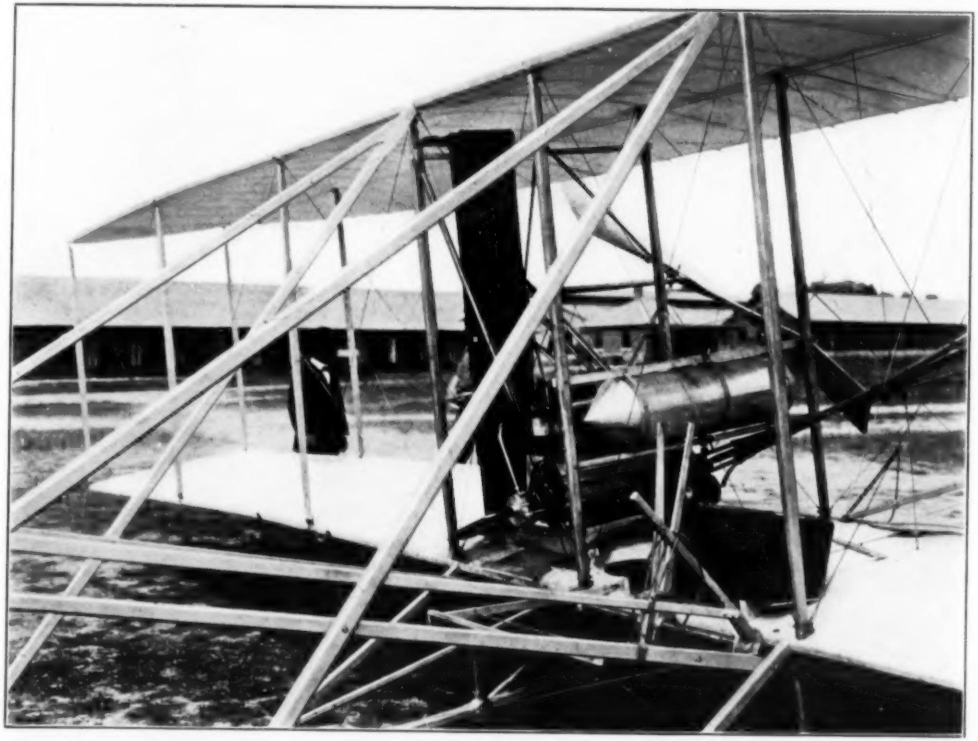

Fig. 14 Wright Brothers' Aëroplane; Details of Construction

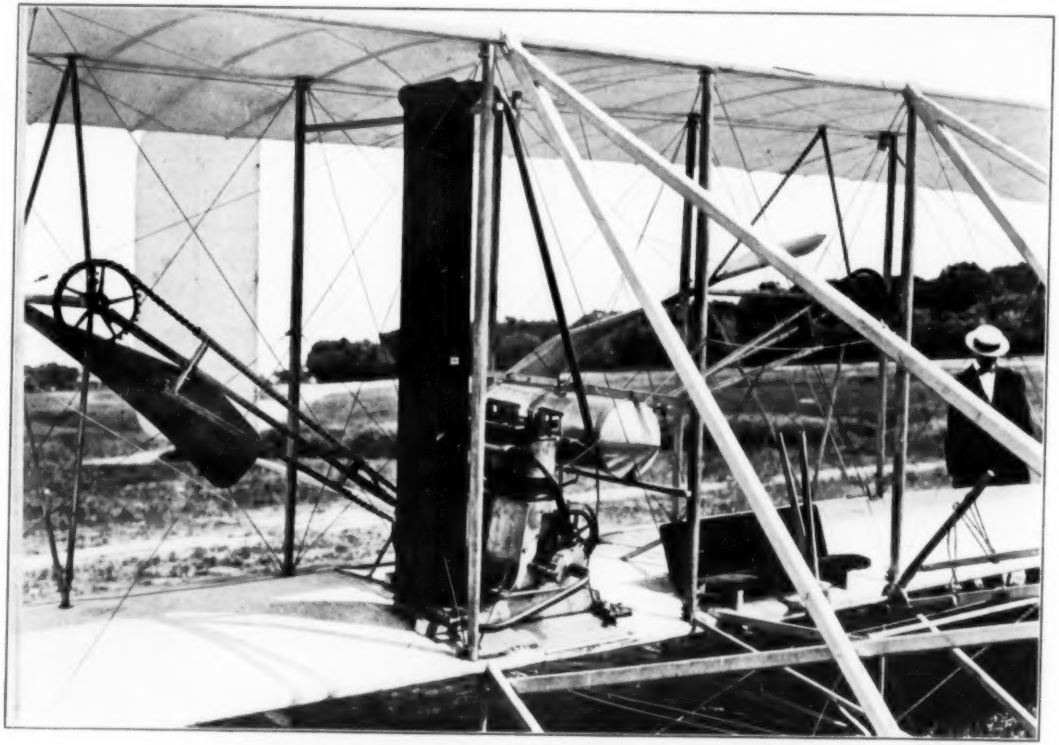

Fig. 15 Wright Brothers' Aëroplane; Details of Construction

FIG. 16 WRIGHT BROTHERS' AËROPLANE; DETAILS OF CONSTRUCTION, REAR VIEW

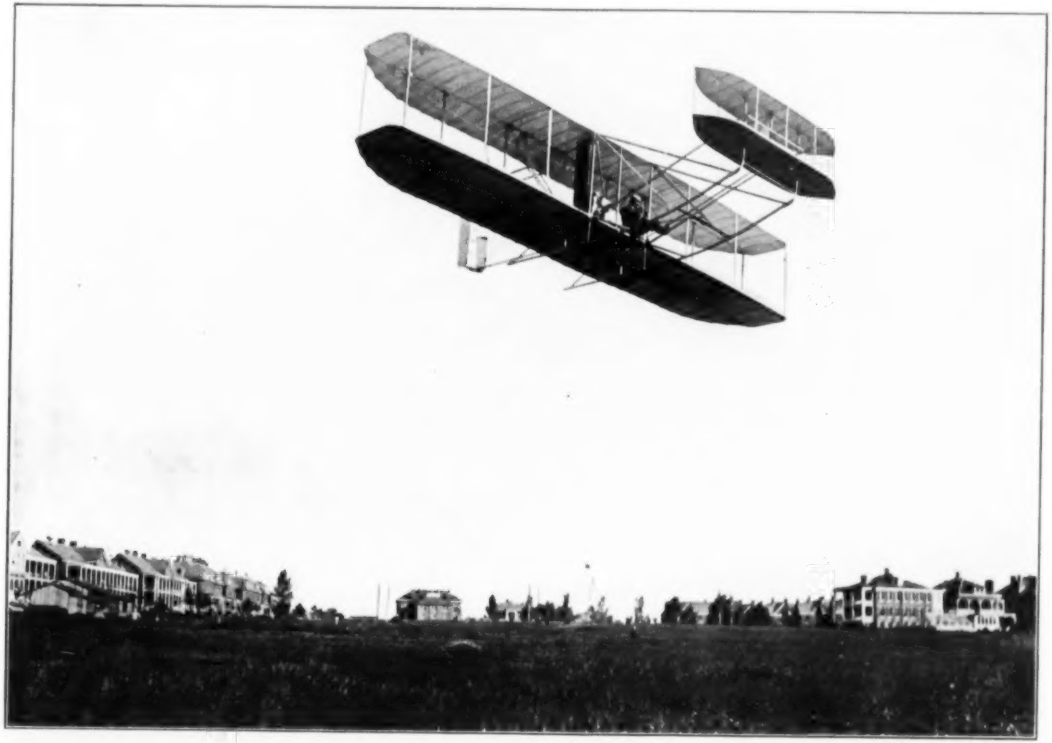

Fig. 17 Wright Brothers' Aëroplane, Fort Myer, Va., September 9, 1908

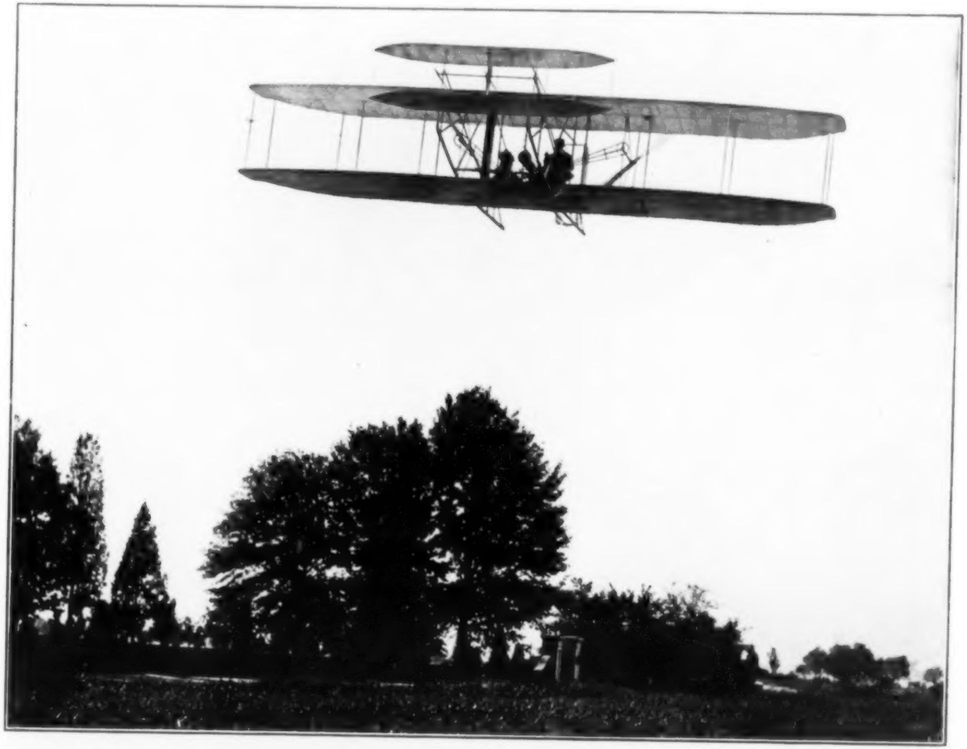

FIG. 18 WRIGHT BROTHERS' AËROPLANE, FORT MYER, VA., SEPTEMBER 9, 1908

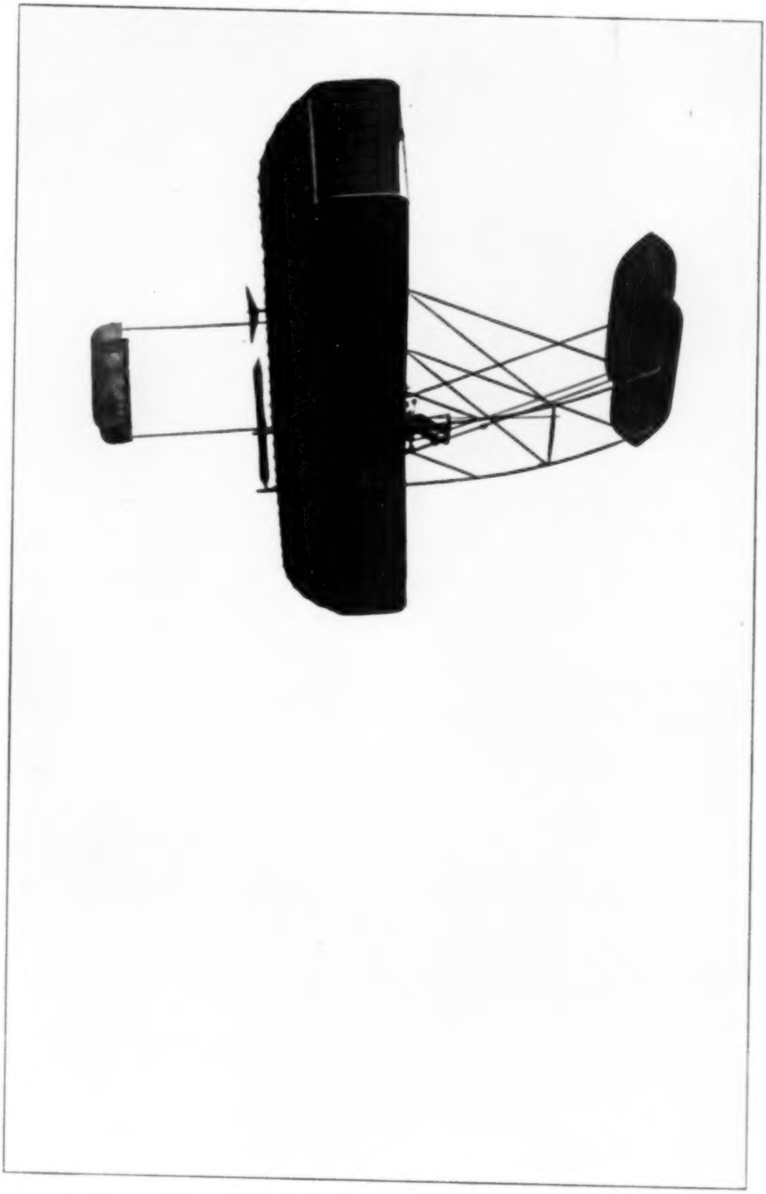

FIG. 19 WRIGHT BROTHERS' AËROPLANE, FORT MYER, VA., SEPTEMBER 12, 1908

FIG. 20 WRIGHT BROTHERS' AËROPLANE, FORT MYER, VA., SEPTEMBER 12, 1908. TIME OF FLIGHT, 1 HR., 14 MIN., 20 SEC.

Fig. 21 Wright Brothers' Aëroplane, Fort Myer, Va., September 12, 1908. Time of Flight, 1 Hr., 14 Min., 20 sec.

Fig. 22 Wright Brothers' Aëroplane, Fort Myer, Va., September 12, 1908; Ready for the Start; Orville Wright and Passenger

Fig. 23 Wright Brothers' Aëroplane, Fort Myer Va., September 12. 1908. Orville Wright and Passenger. Time, 9 Min., 6 Sec.

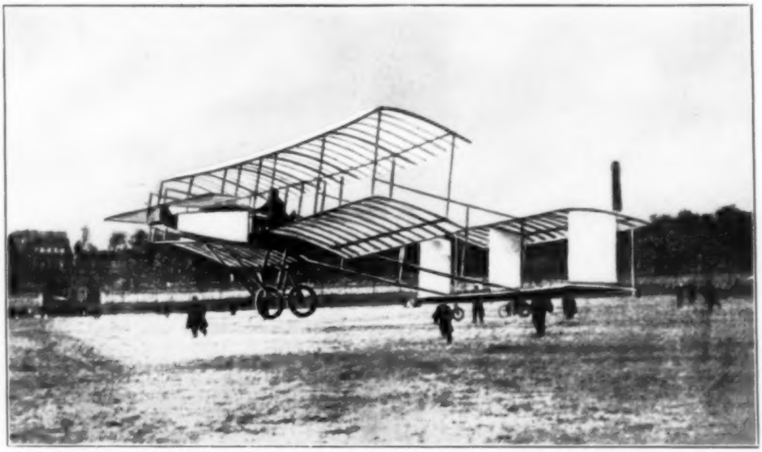

Fig. 24 Farman Aëroplane

Fig. 25 "June Bug" Aëroplane, Hammondsport, N. Y. Aërial Experiment Association

METAL CUTTING TOOLS WITHOUT CLEARANCE

By James Hartness, Springfield, Vt.
Member of the Society

This paper sets forth a turning tool that is intended to cut without clearance.

2 It consists of a cutter and a holder so constructed as to allow the cutter a slight oscillatory freedom in the holder. The center line on which the cutter oscillates is substantially coincident with the cutting edge. The oscillation of the cutter about the center line does not affect the position of the edge, but it does allow the face of the cutter to swing around to conform to the face of the metal from which the chip is being severed.

3 The objects of this construction are to make possible the use of more acute cutting edges in order to reduce the cutting stresses; to equalize wholly or partly the unbalanced side pressure on the cutting edge; and to obtain a rubbing contact to prevent lateral quivering.

4 In order to bring out these objects it is necessary to analyze briefly some of the conditions under which metal is worked in a lathe, dealing particularly with cutting angles, clearance of cutting edges, and the importance of minimizing the tendency of the work and tool to separate under cutting stresses.

5 No attempt is made to discuss the forms of cutting edges for withstanding the heat of high speed service. High speed tool forms have been ably and perhaps conclusively treated in the paper by Mr. Fred. W. Taylor and its discussion, and in the papers of Dr. Nicolson before this Society and before the Manchester Association of Engineers.

6 The generally accepted cutting angle of greatest endurance under high speed is about 75 deg., and the angle of least resistance,

To be presented at the New York Meeting (December 1908) of The American Society of Mechanical Engineers. All papers are subject to revision.

References mentioned: Dr. J. T. Nicolson's papers in Transactions of Manchester Association of Engineers, 1903, and in Transactions of this Society, p. 637, vol. 25, 1904; Mr. Fred. W. Taylor's paper, vol. 28, 1907; also cuts on p. 333 in Dr. Nicolson's discussion of Mr. Taylor's paper.

according to some of Dr. Nicolson's tests, is about 60 deg., with an increase *below* as well as above that angle.

7 The cutting angles of the tool described in the present paper may be varied from the present orthodox angles down to 30 deg. or less, according to the nature of the work.

8 The results obtained by Dr. Nicolson, which showed an increase in cutting stress for tools more acute than 60 deg., may have been due to the cuts having been run without cutting oil or suitable cutting lubricant. Furthermore, the comparative lack of durability of the more acute edge below 70 deg. may have been due either to heat or lateral quivering or both. The heat would have been greatly reduced by a liquid cooling medium, especially one having some suitable lubricating qualities, and the lateral quivering may now be eliminated by means explained in this paper. The thin edge of an acute tool is obviously the least suited to carry off heat or to withstand the quivering incident to cutting.

9 Having mentioned the great work of Mr. Taylor and co-workers and of Dr. Nicolson, it is necessary at once to disclaim any pretension at contributing valuable data, such as are found in the papers of these truly scientific researchers. Nothing of the kind is possible at this time. All that is attempted is to suggest a scheme for widening the field of investigation.

10 Instead of approaching the subject as a scientist bent on getting exact data regarding performance of certain existing forms of tools and machines, the writer's line of approach has been from the standpoint of a designer and manufacturer of lathes, and particularly lathes of the character of the Flat Turret Lathe.

THE CLASS OF WORK HERE CONSIDERED

11 The means for cutting set forth should be considered from the standpoint of one who sees nothing but lathe work under 20 in. in diameter, and of the kind usually found in any machinery building plant, whether it is a navy yard, railroad shop, or automobile building plant; not that the means are of no value in larger work, but being out of the writer's range of experience, such work was not considered in designing the tools described.

12 A more exact description of the range of work for which this tool is intended would be: lathe and turret lathe work under 20 in. and over 4 or 5 in. in diameter, and less than 8 or 10 in. in length; also work up to 2 and 3 ft. in length, of diameters under 3 to $3\frac{1}{2}$ in. and generally over $\frac{3}{4}$ or 1 in.

13 It includes three classes of work: *a*, chuck work, having diameter generally exceeding length, and held wholly by a chuck or face plate; *b*, bar work, which is held in a chuck and steadied by back rests; and *c*, work having dimensions similar to bar work, but which must be turned on center points, with or without following and fixed steady rests.

14 It will be noticed that this excludes all of that kind of larger and heavier lathe work in which the principal duty of the lathe is the rapid removal of the stock. In the particular branch of work under consideration the rapid removal of stock is important, but not paramount.

15 Although the field of work includes all kinds of steel and cast iron, this paper will deal only with the standard open hearth machinery steel of about 20 points carbon.

16 In work supported on centers and in chucking work, the connection between the work and tool includes a number of joints, both for sliding the tool in relation to the work, and for the rotation of the work. Each of these joints has more or less slackness, and each of the slides and other members is more or less frail in structure. With a mounting of this kind the cutting edge of the tool does not pass through the metal without swerving and flinching.

TYPE OF TOOLS USED

17 In the class of work under consideration each piece has several diameters, with shoulders which should be accurately spaced and formed. Nearly all the shoulders required in this class of lathe work are the so-called square shoulders.

18 In engine lathe practice these shoulders are "squared up" by a side tool after the other turning has been done by a round nose or diamond point tool, but in the turret lathe for bar work these shoulders are produced by the same tool that takes the stock removing cut.

19 The tool used in turners for bar work cuts on the same principle as the engine lathe side tool; that is, its rake or top slope is almost wholly side slope, and its cutting edge stands at an angle of 90 deg. to the axis of the work.

20 In the engine lathe a tool of this character has generally been unsatisfactory for rapid turning, yet in the turret lathe this very tool seems to be universally used for all bar work. The difference in performance seems to be due to the difference in mounting. It works well where there is no chance of vibration, but trouble begins

when it is used in a machine like the engine lathe or turret-chucking lathe in which the work is supported by one part of the machine and the tool by another, and the true path of the cutting tool through the metal is dependent on the entire structure of the machine, there being nothing to prevent quivering.

21 The no-clearance tool to be described is a side tool without clearance. Its under face bears flatly against the work, thereby preventing the lateral quivering which has previously made this type of tool inefficient.

MEANS FOR IMPROVING EFFICIENCY

22 A machine's efficiency is proportional to its strength to resist its working stresses. There are two ways to increase this efficiency; *a*, by strengthening the machine; and *b*, by reducing the stresses for a given result.

23 In the writer's previous work the strengthening of the machine has been accomplished by the elimination of unnecessary features, and placing the necessary joints for obtaining the various motions in the least objectionable positions. But since this has been so fully outlined in a semi-commercial treatise entitled The Evolution of the Machine Shop, it is unnecessary to make further reference to the special forms of design therein set forth, except to say that a single-slide scheme of lathe design was adopted to eliminate the complicated and frail construction of the multi-slide tool carriage which is now in almost universal use in all standard machine tools.

24 The next step was to devise a means for minimizing the stresses at the cutting edge, and the object of the present paper is to explain how this result has been obtained.

25 This reduction of stresses may not be important in roughing work in which a flinching of the work or machine may be disregarded so long as the machine continues to crush off the metal, but for the kind of work mentioned in this paper it has been considered of first importance.

Cutting Stress

DIRECT CUTTING STRESS

26 For the purpose of analysis the cutting stress may be divided into three elements: the direct cutting stress, the separating stress, and the tendency to quiver, which we will consider in turn.

27 By direct cutting stress we mean that part of the stress that is directly downward in a lathe. With all other conditions unchanged,

we should expect to find that an acute-edged tool would offer the least resistance, and that the difference in direct cutting stresses for tools of varying cutting angles would show a marked reduction in favor of the more acute tools.

28 Dr. Nicolson's experiments below 60 deg., already mentioned showed, an increase in cutting stresses and a marked loss in endurance, but these tests were on dry cutting without the benefit of a lubricant or a cooling solution. The thin edge tool is undoubtedly benefited more than the blunt edge tool by lubricant or cutting medium. Just what cutting angle would be the best under conditions of most efficient cooling medium may not yet be fully known.

29 That there is no marked difference in the blunter tool of varying cutting angles really does not affect the situation when we try the real cutting or sliding angles, which may be roughly stated to be efficient in proportion to their acuteness.

30 It is obvious that the least direct cutting stress for a given depth and feed would be obtained by a straight-edge tool, and one that would take a chip in which there is the least molecular change.

31 Crushing and partially or wholly shearing the chip into chunks which are three or four times the thickness of the feed undoubtedly increase the working stresses and heat.

32 The cuts accompanying Dr. Nicolson's discussion, p. 333, vol. 28 of Transactions, clearly illustrate the great distortion that takes place even in cutting with an acute tool of 60 deg. and a straight edge. This tool does not have even the disturbing element of shearing action at the edge of the chip, but the experiment shows the distortion of nearly every part of the chip. A tool having a round nose or a blunt edge would doubtless show still greater distortion.

33 A flat top slope should have a straight cutting edge. The more the edge is rounded the greater the conflict of the metal crowding to the edge. The flow of metal on the top slope of the round nose does not move in one direction wholly, but tends to travel towards the center of the curve. The conflict of currents of metal which approach the center from various parts of the curved cutting edge increases the direct cutting stress.

34 The crushing process of the present scheme of turning is due both to the bluntness of the cutting angle and the shape of the edge. A curved edge should have a curved top slope in order to remove the chip with the least distortion of the metal. The curved top slope for this purpose would make the shape of the cutting edge similar to the cutting edge of a carpenter's round-nosed chisel. This form of

tool is not offered as a practical form, but is mentioned to emphasize the unnatural flow of the chip that must take place on the flat top slope of a round nose tool.

SEPARATING STRESS

35 By separating stress we mean that stress which, in turning a shaft, forces the tool outward radially. Increasing this stress causes the work and tool to move apart, and results in variation in diameter, also in irregular and generally inaccurate product, particularly when the rough stock runs eccentric or irregular. Although this separating stress may be lessened by giving the tool more back slope, this is possible only in tools taking light depth cuts. A lathe tool, however, which takes a cut like a side tool, gives little or no tendency to separate radially.

36 With the side tool set at an angle of 90 deg. to the travel of the feed, the feeding stress does not tend to force the work and tool apart; in fact, this tool may be set so as to produce a slightly beveled shoulder either side of the 90 deg. so as either to draw the work and tool together when making an overhanging shoulder or to force the work and tool apart when producing an external bevel.

QUIVERING STRESS

37 The quivering stress due to the nature of the chip is affected by the cutting angle of the tool. The chunks which make up the parts of a chip are less firmly united in a chip taken by a tool of 70 deg. cutting angle than by a tool of 50 deg., and of course the more firmly united chunks give a more continuous chip with the least vibration of stresses.

38 In turret lathe practice, especially in bar work, the tool and work are held together by a back rest which follows on the surface produced by the cutter, and in some kinds of turret-chucking work the tools for interior work are mounted on boring bars which take bearing either in the work or in the chuck which holds the work. When tools get this steadying support directly on or in the work, they are freed from the chattering due to the machine mounting, but not free from that due to their own frailty or to the intermittent flow of the chip as it is taken off in chunks.

RELATIVE DESTRUCTIVE EFFECTS OF HEAT AND LATERAL QUIVERING

39 The writer is not unmindful of the effect of heat in the destruction of the cutting edge, and fully realizes that no perfection of mounting of the work and tools will prevent destruction of the cutting edge of the tool by heat, but wishes to bring out the importance of the destructive effect of chattering which is ever present in standard types of machine tools. Heat is undoubtedly most destructive when roughing at high speeds, but the quivering plays a very important, if not the greatest part in edge destruction when finishing at the usual speeds.

40 Many machines are not run up to the high speed limit of the cutters. Even when provided with ample driving power, the strenuous life of attending a high speed machine is a little too much for the average man. As the speed is reduced, the quivering gains in relative importance, which should be taken into account in considering the no-clearance tool. With the slower speeds, tools should be used that give the best results at those speeds.

OTHER CONSIDERATIONS

41 The failure of the keen edge under normal cutting conditions, and its surprising endurance under some abnormal conditions, seem to indicate great possibilities open to any scheme that would maintain the best conditions. For instance, at one time, we have seen the edge of a diamond point broken off by an ordinarily heavy chip and at another time we have seen a similar tool deeply imbedded into the metal without breakage, the tool having taken a plunge and lifted or plowed up a chip of enormous proportions *without breaking the tool.* Every lathe hand has seen this performance. Usually it ends with breaking the tool or the center of the lathe, or both, but occasionally the lathe is stopped without breakage; then the lathe hand by great care may separate the work and tool without breaking the edge. The immense chip plowed up by a frail tool demonstrates what a cutting tool can do under some conditions.

42 We are also aware that under some conditions a cutting tool will actually sharpen itself in the process of cutting, yet neither of these results is regularly maintained. They suggest, however, the possibility of supplying a means by which they can be maintained in regular work.

CLEARANCE

43 Since the birth of the slide rest lathe, in which the tool was first guided by mechanism, turning tools have been given clearance and it has been assumed that they would not cut without clearance. Of course it is well known that the orthodox lathe tool goes out of commission after losing its clearance, but that does not demonstrate that a tool cannot cut without clearance. It only proves that the present tools require clearance as they are now formed and mounted.

44 A tool which has been ground for clearance, and set in such a position that its under face is at an angle to the shoulder produced, presents but a small area to the shoulder of work when the clearance of the extreme edge has given way. The area is so small, compared with the stress of the abrading metal passing it, that it rapidly scores and wears into a rough surface standing at a "negative" clearance angle. A tool with a negative clearance and rough surface quickly goes from bad to worse.

45 The tool which has by chance been set in an engine lathe so that a comparative large area of the under face rides on the wall of metal does not wear away, because its surface is not subjected to as great abrading pressure per unit of area. Its area is sufficient to withstand abrasion.

46 It was assumed by the writer that increasing the contact of the under face of the tool against the face of the work would make it possible to cut without clearance. The advantage of a no-clearance tool is that its face rides on a good area and supports the under edge against the pressure of the chip, thus relieving the edge from the one-sided pressure which must be borne by a tool having clearance. This one-sided pressure may be wholly or only partly relieved.

47 Of course, in all of the former types of tools the cutting edge must withstand the stress, which is wholly one-sided, excepting for the occasional condition stated, in which a cutting tool obtained by chance a bearing on its clearance face.

THE NO-CLEARANCE TOOL

48 In order to enable the tool to ride flatly against the wall of metal from which the chip is being removed, we have mounted it to allow a comparatively free swiveling action on a center line that is substantially coincident with the cutting edge of the tool. When the tool is so mounted the pressure of the chip on the top slope tends to throw the so-called clearance face against the shoulder, for the

mounting allows the tool to swing around to the angle that may be necessary to fit any work form, from a straight surface in planer work and the nearly straight surface in work of large diameter down to the angle of a helix obtained by the coarse feed on work of relatively small diameter.

49 A tool so mounted either swings automatically to adapt itself to angularity of feed, or may be swung by hand as soon as the cut is started. Its natural tendency holds it snugly against the metal, but the force may be varied from one that equalizes the stress on each side of the cutting edge down to a very slight stress which only holds the tool in no-clearance position. An important feature is that the tool is free to swing around to offset the unequal wear on the "clearance" face.

50 In the early experiments the cutters used were clamped rigidly in a holder, which in turn was pivotally mounted on a fixed holder. The cutting edge of the tool was so located as to stand exactly on the center line of the swiveling holder.

51 In the later experiments the scheme has been simplified by loosely mounting the cutter itself, providing it with a round bottom struck from a center line which is near the cutting corner of the tool. The cutting edge is usually standing at an angle to its center line of swivel, giving the tool a front slope. The scheme of inclining the cutting edge to the line of swivel was adopted for the purpose of using a bar-shaped tool in which its shape could be maintained by grinding, for with this shape grinding back the end provides for the wearing down of the top edge. This gives the tool a front slope when the swiveling center is kept horizontal. In some cases it may be well to tilt the holder to an angle that brings the cutting edge horizontal.

52 This departure from the ideal center position of the line of swivel is not sufficient to cause any trouble. In fact the pivotal line need not be exactly parallel to the cutting edge, neither is it necessary to have it very near the center line of swivel. It is probable that under some conditions the cutting edge may advantageously be located either above or below or on either side of the cutting edge. The exact location of the cutting edge relative to the center of oscillation partly determines the pressure with which the tool rides against the wall of metal from which the chip is taken.

53 The extreme top edge of the tool, in some instances, has been slightly flattened on the acuter angles, the flat measuring from about $\frac{1}{64}$ in. to $\frac{1}{32}$ in., and standing either 90 deg. from the so-called clearance face or sloping in either direction. Very good results were obtained

by giving it a negative side slope standing at a maximum angle of from 10 deg. to 15 deg. from the horizontal. This top flat seems to make a good resting place for the false edge, and it may be that its successful operation is dependent on the false edge.

54 One interesting phase of these experiments has been the comparative willingness on the part of the tool to relieve the carriage of the duty of feeding. This first became apparent when the carriage continued to advance after the feed had been "thrown out." This self-feeding feature, of course, cannot apply to the action of planers, boring mills, or work of large diameter. It is mentioned here only to indicate the absence of resistance to the feeding motion under some conditions.

55 The ultimate outcome of the use of acute angle tools may be to allow each tool to take a heavy cut on small diameters to determine its own feed. In the turret lathe this would be a distinct advantage.

CHIP LIFTER AND CHIP CONTROL

56 The chip produced by the acute angle tools is a continuous chip possessing great lateral strength. The continuous chip is preferred by any operator who has had experience with hot chips thrown off by tools of blunter angles, but while this particular feature enables him to observe the action of the tool closely without risk, the continuous chip in itself becomes troublesome, if allowed to run too long without breaking. In some of the first experiments with this tool, chips having a depth of about $\frac{3}{8}$ in. and produced by a feed of six to the inch, were found exceedingly troublesome, especially when allowed to run out to lengths of 5 to 15 ft.

57 The lateral stiffness of the chip of the more acute tool made it possible to increase the tearing open or splitting effect which occurs in cutting metals. To increase the tearing action it is necessary to allow the chip, after it has passed from the edge of the tool, to pass over a lifter in the form of a wedge, either formed integrally with the tool or placed in the path of the chip near the tool, having an angle that not only assists in tearing the metal ahead of the tool, but also relieves the slope of the tool near the edge from an important part of the labor.

58 In other words, a chip possessing lateral strength made it possible to carry an important part of the cutting or splitting action farther away from the extreme edge. The heat generated by this part of the work, because of its position, of course in no way reduces

the life of the extreme cutting edge. Experiments with the chip-lifting scheme seem to indicate that under ideal conditions the duty of the extreme edge of the tool may be simply to cut through metal which may be under more or less of a tearing or splitting stress.

59 Although this chip-lifting effect may be produced by a top slope having a curved surface, it has seemed best for the convenience of grinding the tool on an ordinary wheel to keep the top slope of the cutter a flat surface, and to introduce this chip-lifter as a separate member, either as a part of the tool holder or in conjunction with the chip-breaker to be described.

60 Although it is, as was stated, a satisfaction to be able to stand near the cutting tool and to have some assurance of the direction in which the chip will travel, and to know that it is integral and not shooting out in hot chunks at all angles from the tool point, a continuous chip is nevertheless troublesome. Even with blunt tools, the curling chips which are sometimes used to illustrate ideal working conditions of a machine require the constant attention of the operator, and either a very large receptacle which doubles the floor space required for the machine or the almost constant attendance of an extra man for removing the chips from the room.

61 The use of the more acute angles increases the chip troubie, and may in some instances make it advisable to retain the blunt cutting angles, or at least, tools which produce tolerable chips.

62 For turning bar work in the turret làthe it has seemed best to adopt a chip-breaker which produces a fracture by placing an obstruction in the path of the chip at such an angle that the chip is bent, either by lifting or depressing, or both, shortly after it has left the tool,to an extent beyond its breaking point. In order to employ the chip-lifter most efficiently for the purpose of relieving the top slope of the cutting tool, the writer has preferred to use a chip-breaker which depended on depressing the chip after it passed over the chip-lifting incline. A breaker of this kind breaks the chip in lengths varying from $\frac{1}{2}$ to 3 in.

CONCLUSIONS

63 The no-clearance cutter relieves the edge from the one-sided pressure.

It prolongs the life of the cutter by allowing abrasion on its face without producing negative clearance.

It prevents lateral quivering.

It converts the lip angle into cutting angle, which for a tool of given form constitutes a gain of from 5 to 10 deg. in cutting angle.

It has extended the working range of the side tool which gives the minimum separating stress.

It has made possible the use of acute-angled tools which reduce the cutting stress, thereby increasing the output of machines which have been limited by lack of pulling power.

The reduction of the cutting and separating stresses has increased the accuracy (or output, which is generally interconvertible with accuracy) on nearly all lathe work.

This reduction also increases the output which has been limited mostly by the frailness or the slenderness of the work.

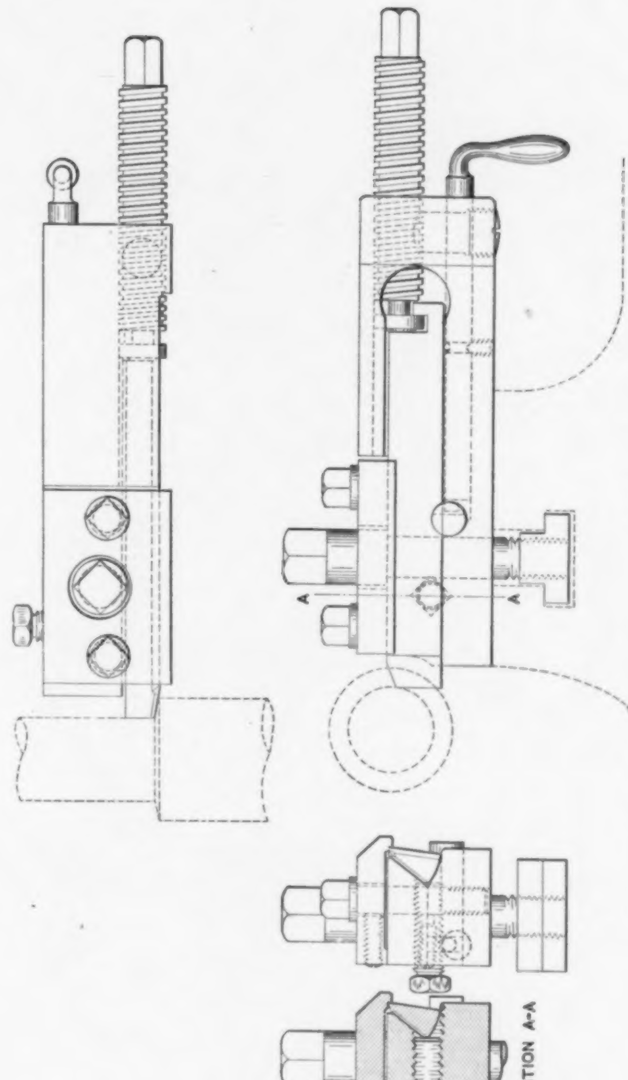

Fig. 12 Form of Turning Tool and Holder for Engine Lathe

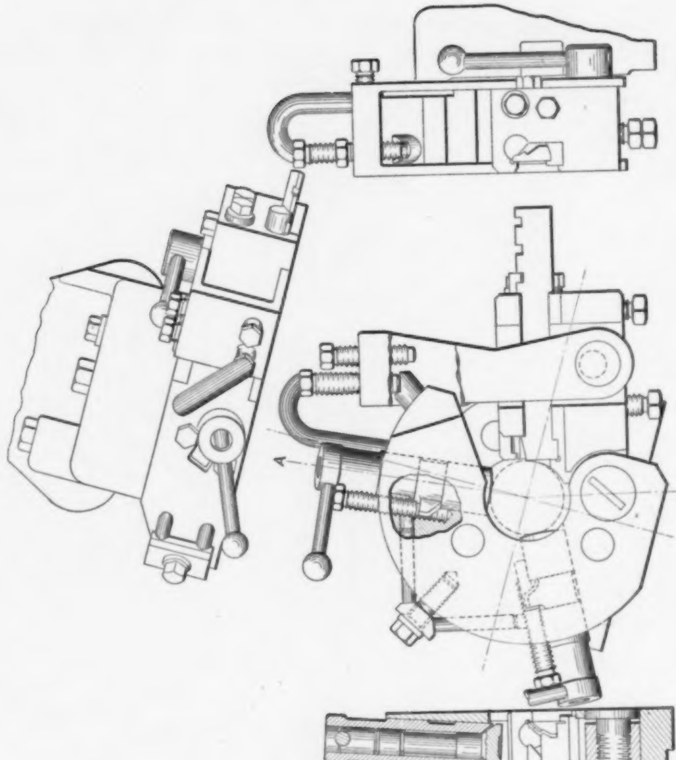

FIG. 13 TURNING TOOL FOR FLAT TURRET LATHES

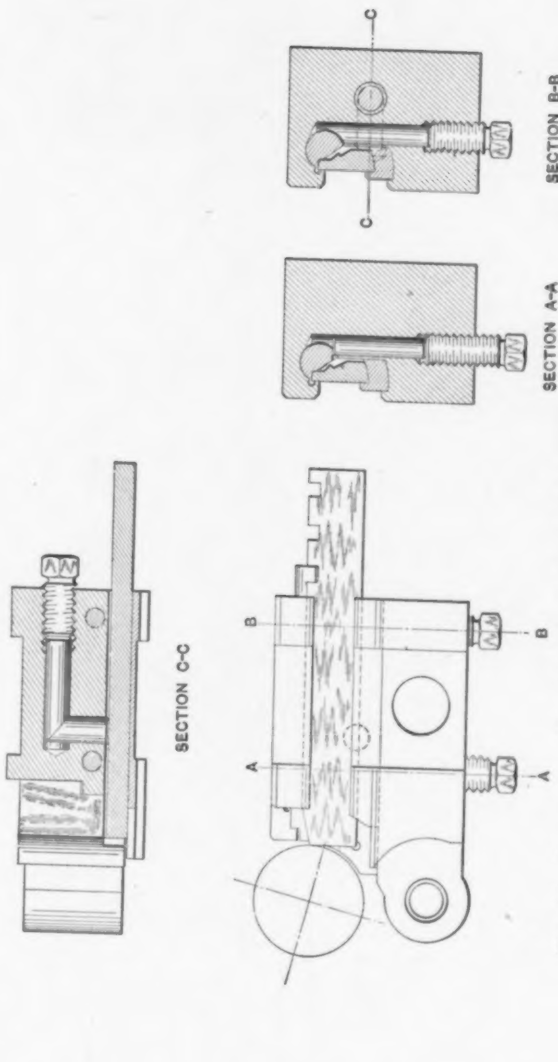

Fig. 14 Details of Turning Tool Showing Means of Holding Cutter and Limiting the Oscillation

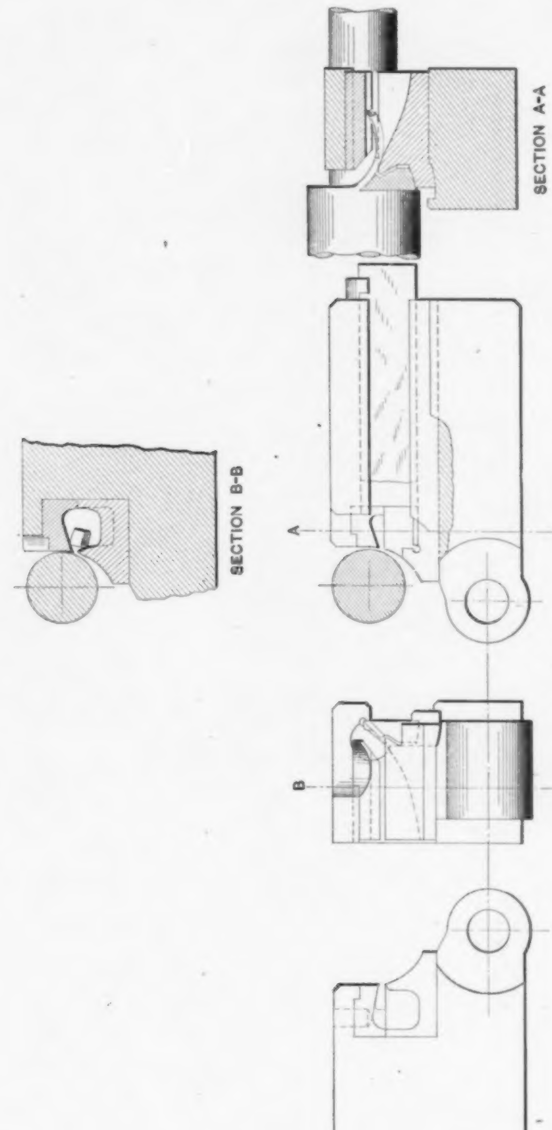

Fig. 15 Details of Turning Tool Showing Chip Breaker for a Curling Chip

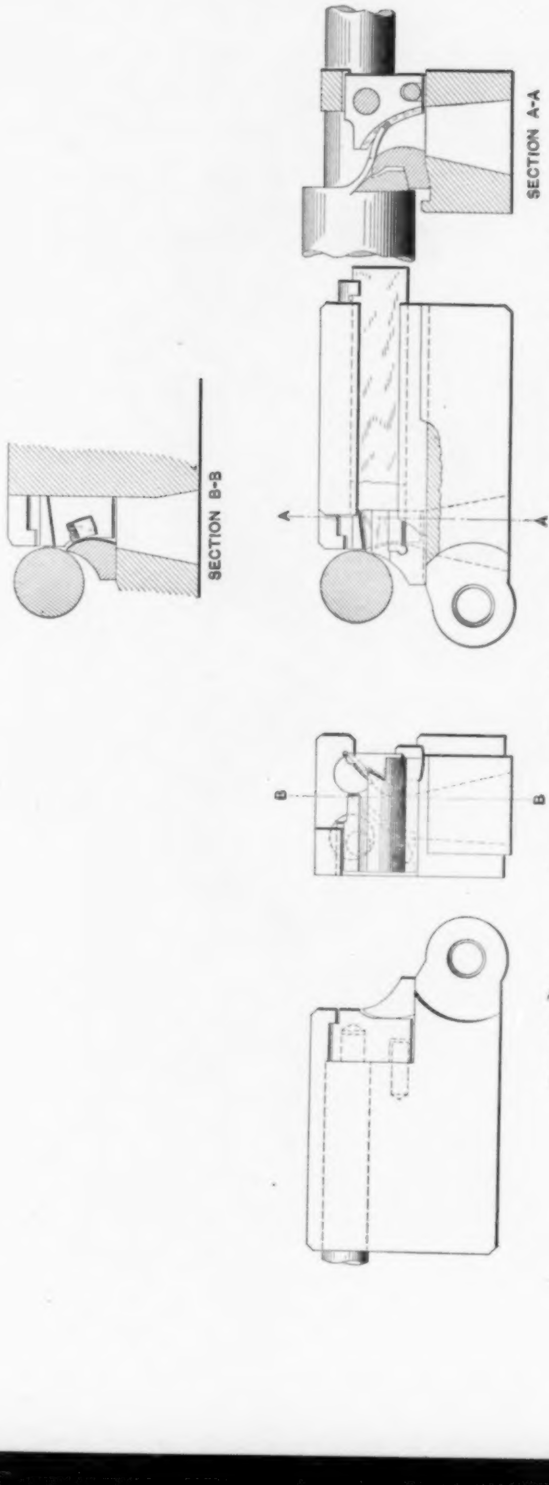

FIG. 16 ALTERNATE SCHEME FOR CHIP BREAKER FOR A COMPARATIVELY STRAIGHT CHIP

Fig. 1 Characteristic Chips (about double size). Chips at the Left made by Diamond Point Tool having 70 deg. Cutting Angle. Chips at the Right made by No-Clearance Tool, 45 deg. Cutting Angle.

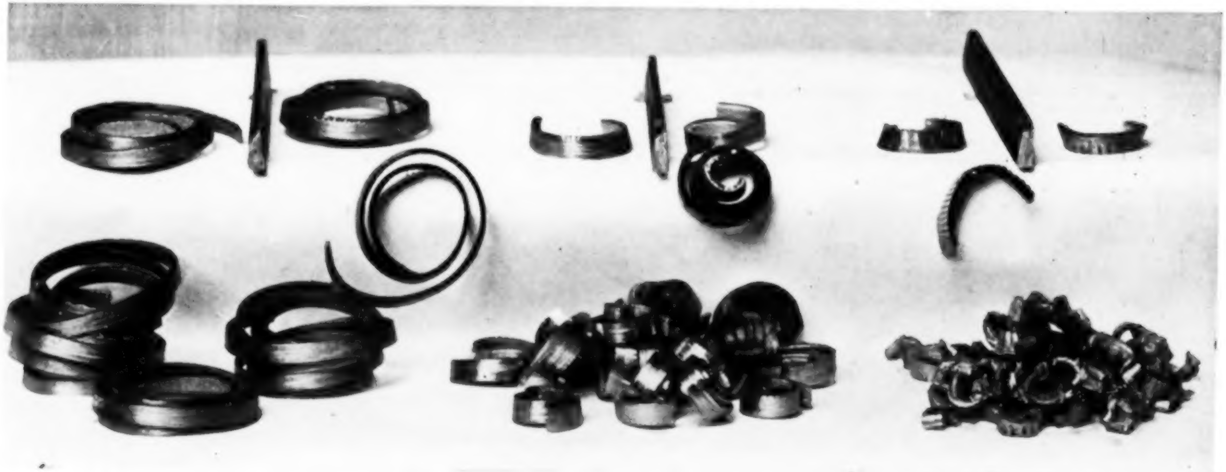

Fig. 2 Samples of Chips and Cutters: Cutting Angles from Left to Right 45 deg., 60 deg. and 75 deg. These Chips were Produced in an Engine Lathe with Holder Shown in Fig. 12

The chips were confined edgewise between the body of work and the end of the holder. The breakage of chips taken by the 45 deg. tool were due to chips getting caught between the work and tool holder, usually due to the irregular winding of the chip. The chips produced by the 60 deg. tool wound up till the circle was greater than the chip could take without breakage.

Fig 3 Samples of Chips: Those Held in Hand Were Produced by Blunt Side Tool having 75 deg. Cutting Angle. All Other Chips were Produced by Tools having Cutting Angle of 45 deg. or Less.

THE CHIPS IN THE THREE SMALL PILES AT THE RIGHT ON THE TOP ROW AND THOSE ON THE LOWER ROW WERE BROKEN BY CHIP CONTROLLER SHOWN IN FIG. 15. THESE CHIPS WERE PRODUCED BY CUTTERS NO. 2 AND 3 IN FIG. 4 AND 5, RUNNING AT 40 to 45 FT. PER MIN. (PERIPHERY SPEED) AND 22 FEED PER INCH; DEPTH OF CUT $\frac{7}{16}$ IN., REDUCING FROM $1\frac{3}{4}$ IN. DOWN TO $\frac{7}{8}$ IN.

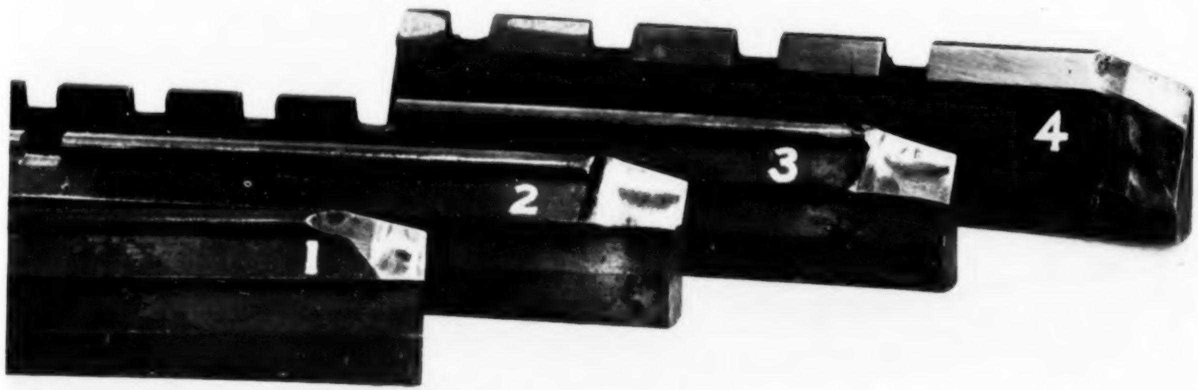

Fig. 4 Cutters Used in the Flat Turret Lathe

Illustration shows the abrasive contact of chip on the top slope. No. 1, 2 and 3 were used in turner, fig. 10. No. 4 shows one of the earlier forms.

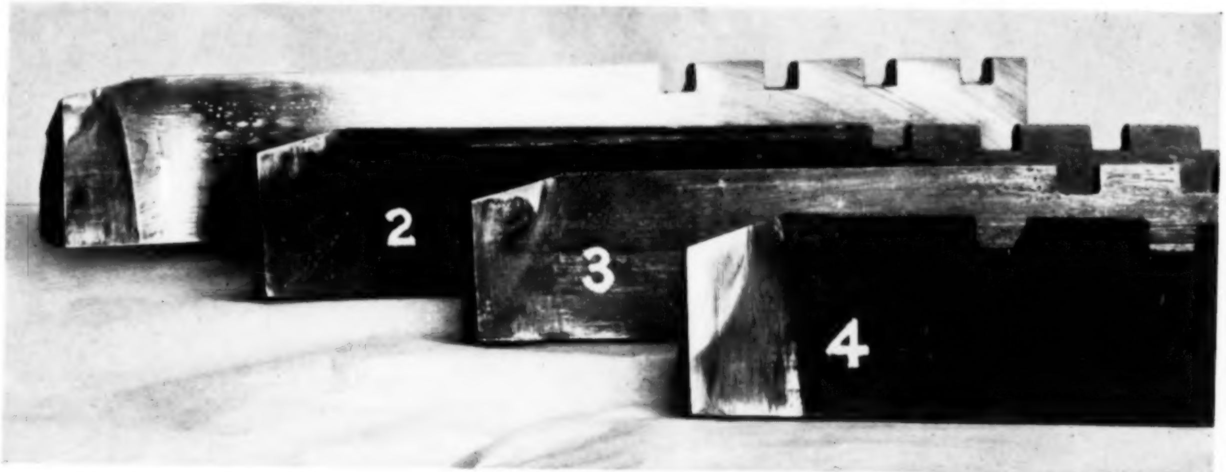

Fig. 5 Reverse Side of Cutters Shown in Fig. 4

Illustrating the rubbing contact of the tool against the shoulder of the work. Each tool bears the same number in both cuts.

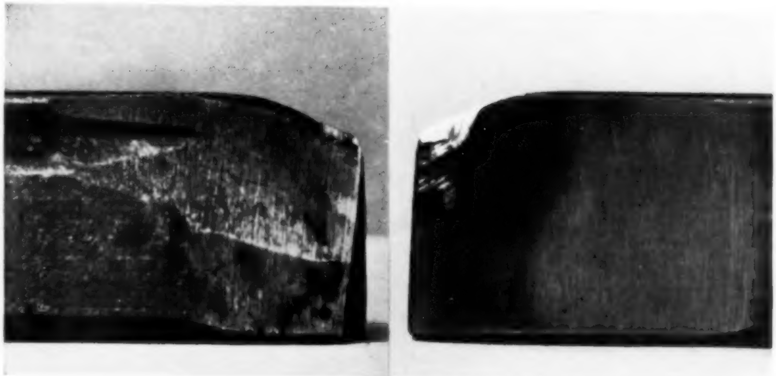

Fig. 6 No-Clearance Tool, Full Size

Showing an equal abrasive effect on each side of edge. View at the left shows the top slope, the angle of which was increased by chip abrasion. View at the right shows the abrasive effect of the shoulder of the work which reduced the cutting angle, but not as much as the abrasion of the chip increased it.

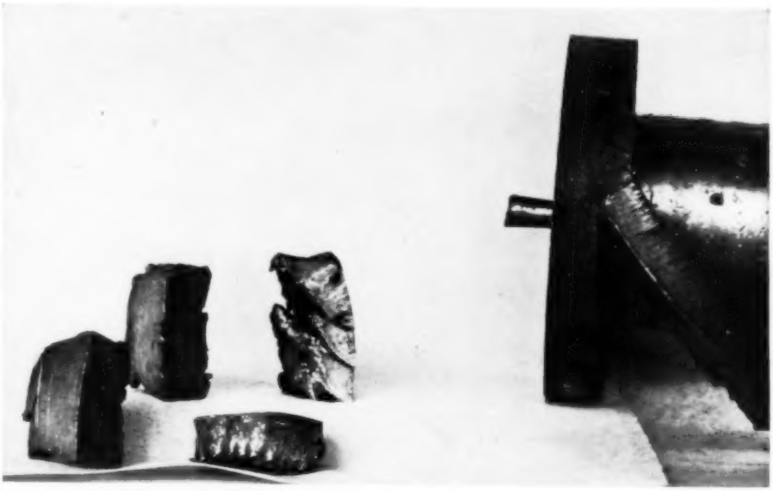

Fig. 7 Sample of Broken Chips and Work with an Unbroken Chip

The view is about one-seventh larger than sample, the exact dimensions being $1\frac{3}{8}$ in. down to about 1 in. diameter. The feed was about 7 per inch, cutting angle of tool about 38 deg., extreme edge 1/32 in. flat. These chips were broken by a scheme similar to that shown in Fig. 16.

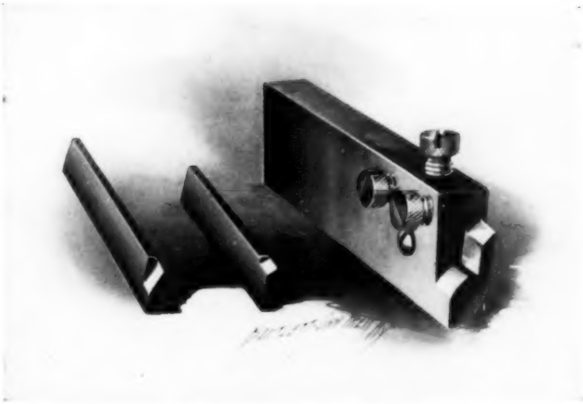

FIG. 8 NO-CLEARANCE TOOL FOR STANDARD ENGINE LATHE TOOL POST, WITH THREE CUTTERS OF DIFFERENT ANGLES

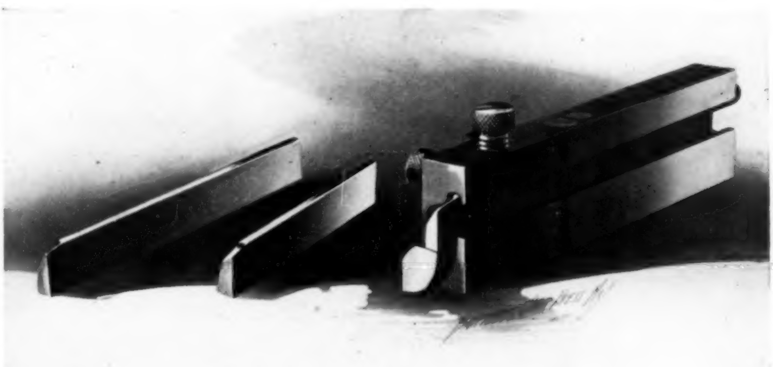

FIG. 9 VIEW OF OTHER SIDE OF TOOL SHOWN IN FIG. 7

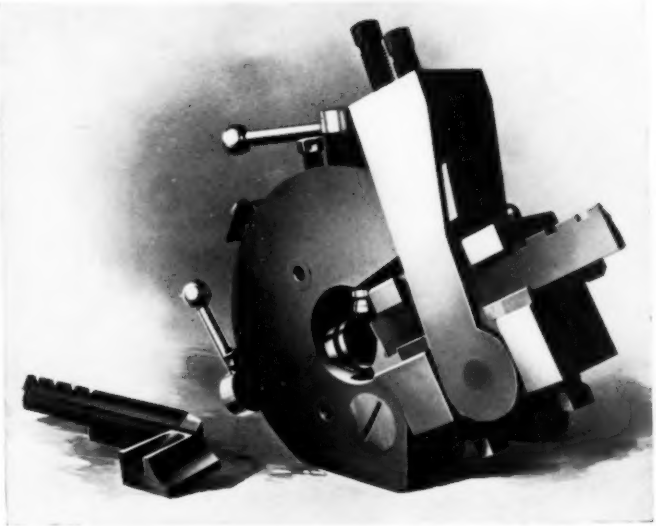

Fig. 10 The No-Clearance Turning Tool for the Flat Turret Lathe

THIS TOOL IS PROVIDED WITH A DOUBLE ADJUSTMENT BY WHICH IT MAY BE SET TO TURN TWO SIZES. SEE FIG. 13–15

Fig. 11 Larger View of the Cutter and Chip Controller Shown in Fig. 10

ARTICULATED COMPOUND LOCOMOTIVES

By C. J. Mellin, Schenectady, N. Y.
Member of the Society

The constantly increasing demand for heavier power, made by most railways in the country during the last decade, and especially by those roads having heavy gradients combined with sharp curves, brought out various designs which on account of rail pressure limitations required so many coupled wheels that the length of the rigid wheel base made them unwieldy to operate with efficiency. This demand for greater power was, of course, greatest in mountain districts where heavy grades and sharp curvatures generally go together, necessitating, for safe operation, comparatively short wheel bases, reduction in engine resistance and wear of wheel flanges and rail, together with moderate weight of the working parts of the engine.

2 In striving to meet this demand, the locomotive designers and builders were brought face to face with an unsurmountable barrier to further progress in the enlargement of engines on the old lines; and in 1902 the American Locomotive Company decided to work out a design of a heavy, powerful locomotive for the Baltimore and Ohio Railroad, having two sets of engines under one boiler, capable of adjusting themselves independently to the alignment of roads with curvatures up to 30 deg. on the principle developed by the prominent French engineer, M. Anatole Mallet of Paris.

3 Mr. Loree, then President of the Baltimore and Ohio Railroad, considered the question seriously; but it was first thought that it would be of no advantage to the Baltimore and Ohio Railroad, even if it proved successful, and the subject was left undecided for some time. In the latter part of 1903, on the recommendation of Mr. J. E. Muhlfeld, who in the meantime had become General Superintendent of Motive Power of the Baltimore and Ohio ordered one engine of this type, which was built at the Schenectady Works of the American Locomotive

To be presented at the New York Meeting (December 1908) of The American Society of Mechanical Engineers. All papers are subject to revision.

Company during the winter of 1903 and 1904, to suit the conditions of that railway.

4 Propositions for building the Mallet type of engine had been made both by Mr. S. M. Vauclain, General Manager of the Baldwin Locomotive Works and by the writer, several years prior to the above date, but the one under consideration is, so far as the writer is aware, the first engine of this type completely designed and constructed in the United States. The original Mallet type of engines built in Europe dates back to the early nineties, but its history would be too extended to embody in this paper.

5 This Baltimore and Ohio locomotive, which was of unusual dimensions for that time, was exhibited at the Louisiana Purchase Exposition at St. Louis in 1904. A great number of locomotives of this type, of various sizes, have since been built for other roads as forerunners of what promises to be the most powerful and efficient type of the freight engine of the future. The form permits of the application of cylinders of largest dimensions, as well as of the largest boiler capacity, by the distribution of the weight over a long wheel base and over many driving axles. Up to the present date a tractive power of about 125 000 lb. has been reached, whereas the ordinary types of engines rarely exceed 44 000 lb.

6 The tractive power P is figured by the usual formula for multiple expansion engines working compound, namely:

$$P = \frac{d_L \, p \, c \, s}{D}$$

in which

d_L = Diameter low pressure cylinder.
p = Boiler pressure.
s = Stroke of piston.
D = Diameter driving wheels.
C = Coefficient obtained from actual practice, and varying with the degree of cut-off and cylinder ratio.

The cylinder ratio being as a rule 1 to $2\frac{1}{2}$, and the cut-off in the high pressure cylinder about 82 per cent the value of coefficient C is about 0.53 at a piston speed not exceeding 250 ft. per minute.

7 For working single expansion, the formula will be that of a simple engine multiplied by 2 or

$$P^1 = \frac{2 \, d^2 \, p \, c \, s}{D}$$

where the symbols are the same, except d, which represents the diam-

eter of the high pressure cylinder, and the value of C equals 0.85, which is accepted for simple engines.

8 The factor 2 is used on the basis that the low pressure engine develops the same power as the high pressure, because the steam supply to the former is reduced in an inverse proportion to the cylinder ratio.

TABLE 1 COMPARISON OF PRINCIPAL DIMENSIONS AND WEIGHTS OF INDIVIDUAL PARTS OF HEAVIEST MALLET ENGINE AND HEAVIEST DESIGNS OF ORDINARY TYPES

Road	Erie	D. & H.	P.B. & L.E.	A. T. & S. F.	A. T. & S. F.	B. R. & P.
Builder	A. L. Co.	A. L. Co.	A. L. Co.	A. L. Co.	Baldwin	A. L. Co.
Type	Articulated 0880	Consol. 280	Consol. 280	Decapod 2100	Decapod 2100	Decapod 2100
Simple or compound cylinders	Comp. 4 cyl. articulated	Simple	Simple	Comp. 4 cyl. tandem	Comp. 4 cyl. tandem	Simple
Diameter and stroke	25 & 39 by 28 in.	23 by 30 in.	24 by 32 in.	17½ & 30 by 34 in.	19 & 32 by 32 in.	24 by 28 in.
Boiler pressure	215 lb.	210 lb.	210 lb.	225 lb.	210 lb.	210 lb.
Diameter of driving wheels	51 in.	57 in.	54 in.	57 in.	57 in.	52 in.
Tractive power	94 800 lb.	49 690 lb.	60 900 lb.	55 300 lb.	62 500 lb.*	55 350 lb.
T. P. working simple	120 000 lb.			63 000 lb.	64 100 lb.	
Total weight	410 000 lb.	246 500 lb.	250 500 lb.	259 800 lb.	266 500 lb.	268 000 lb.
Weight on drivers	410 000 lb.	217 500 lb.	225 500 lb.	232 000 lb.	237 000 lb.	243 000 lb.
Factor of adhesion	4.33	4.38	3.7	4.20	3.82	4.39
Rigid wheel base	14 ft. 3 in.	17 ft.	15 ft. 7 in.	20 ft.	20 ft. 4 in.	19 ft.
Average load per wheel on rail	25 625 lb.	27 200 lb.	28 200 lb.	23 200 lb.	23 700 lb.	24 300 lb.
Weight of main rod	968 lb.	985 lb.	1144 lb.	817 lb.	1028 lb.	1050 lb.
Weight of inter. rod	406 lb.	681 lb.	424 lb.	574 lb.	x	449 lb.
Weight of front rod	133 lb.	188 lb.	260 lb.	158 lb.	x	187 lb.
Weight of back rod	135 lb.	208 lb.	200 lb.	158 lb.	x	190 lb.
Weight of back inter. rod				244 lb.	x	190 lb.
Weight of h.p. piston and rod	790 lb.	782 lb.	693 lb.	1130 lb	1075 lb	830 lb.
Weight of l.p. piston and rod	993 lb.					

* Calculated by the formula used by the Baldwin Locomotive Works for figuring the tractive power of 4-cylinder tandem compound locomotives.

9 The Mallet articulated arrangement presents the advantages of enormous tractive power concentrated in the combination of the two sets of engines with practically no increase in the individual weights of the moving and wearing parts over those of engines of the ordinary

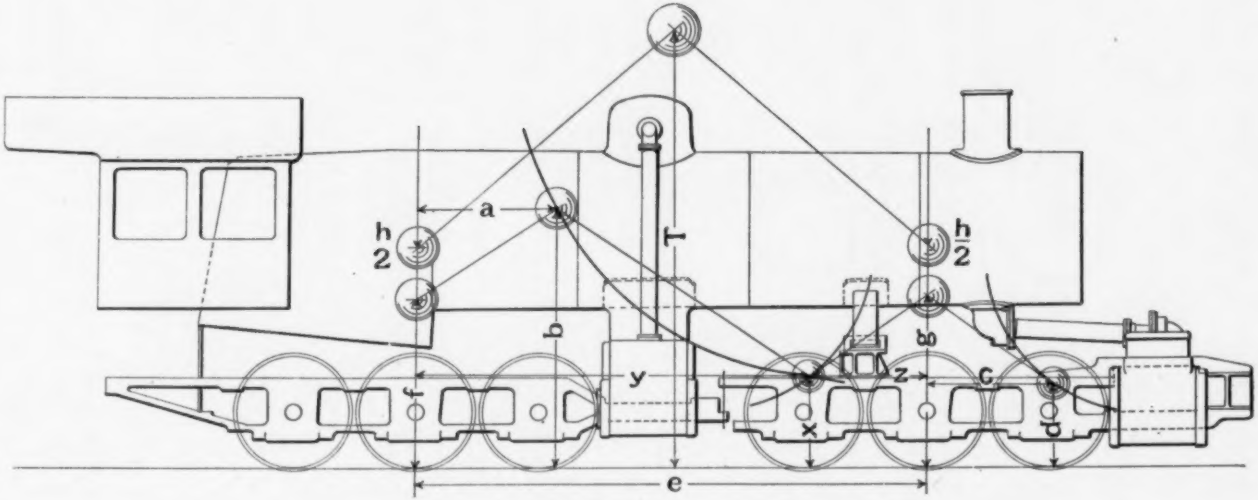

FIG. 1 WEIGHT DISTRIBUTION OF ARTICULATED LOCOMOTIVE

$$a \times b = y \times x \qquad c \times d = z \times x \qquad (a \times b) + (c \times d) = e \times x$$

$$x = \frac{(a \times b) + (c \times d)}{e}$$

$f = b - x \quad f = g \quad g = d \quad g = d + x \quad h =$ dead weights

$$f + \frac{h}{2} + g + \frac{h}{2} = T$$

types; double expansion of the steam; simplicity and ease in operation; and a short rigid wheel base, with the weight distributed over a long total wheel base, resulting in the greatest flexibility and ease on track and bridges. It was also found possible at the very first to provide an engine under the control and operation of a single crew, having double the power of the largest engines of the ordinary type.

10 These advantages are most clearly evidenced by the comparisons in Table 1 between the heaviest engine of the Mallet type ever built and some of the heaviest freight engines of standard types.

11 The comparison in Table 2, however, between one of the lighter designs of Mallet engines and a few engines of the ordinary types, of approximately the same power, clearly shows that the same tractive power is obtained with this type as in other types, but with weights of moving and wearing parts equivalent to those of an engine of half the tractive power.

12 In general, the Mallet articulated locomotive consists of a front system with its frame work, low-pressure cylinders with their

TABLE 2 COMPARISON OP PRINCIPAL DIMENSIONS AND WEIGHTS OF INDIVIDUAL PARTS OF MALLET ENGINE AND DESIGNS OF ORDINARY TYPES OF FREIGHT ENGINES HAVING APPROXIMATELY SIMILAR TRACTIVE POWER

Road	Central Railway of Brazil	N. Y. C. Lines	Erie
Builder	A. L. Co.	A. L. Co.	A. L. Co.
Type	Articulated 0660	Consolidation 280	Consolidation 280
Simple or compound	Compound 4 cyl. articulated	Simple	Simple
Cylinders diameter and stroke	17½ in. 28 by 26 in.	23 by 32 in.	22 by 32 in.
Boiler pressure	200 lb.	200 lb.	200 lb.
Diameter of driving wheels	50 in.	63 in.	62 in.
Tractive power	42 420 lb.	45 700 lb.	42 500 lb.
Tractive power working simple	52 000 lb.		
Weight on drivers	206 000 lb.	208 000 lb.	179 000 lb.
Total weight	206 000 lb.	234 000 lb.	202 000 lb.
Factor of adhesion	4.85	4.5	4.2
Rigid wheel base	9 ft.	17 ft. 6 in.	17 ft.
Average load per wheel on rail	17 166 lb.	26 000 lb.	22 375 lb.
Weight of main rod	417 lb.	821 lb.	848 lb.
Weight of intermediate rod		403 lb.	509 lb.
Weight of front rod	208 lb.	185 lb.	246 lb.
Weight of back rod	92 lb.	201 lb.	210 lb.
Weight of h.p. piston and rod	297 lb.	664 lb.	516 lb.
Weight of l.p. piston and rod	459 lb.		

attachment of guides and rods, one set of driving wheels, cross-ties and boiler supports; and a rear system with the high pressure cylinders and frame work, fixed to the boiler as though an ordinary engine were placed under the rear part of the boiler.

13 The supporting points are of course in the center of their respective wheel bases; and are preferably used as the reference centers for calculating the moments of the individual systems.

14 It will be seen from Fig. 1 that, when the proper weights have been arrived at as a whole, the weight of each system with its center of gravity must be figured out independently, starting with the front system in which the center of gravity falls well ahead of its center of support. As the rear system is by far the heavier, the front system must therefore carry one half of the difference between the two to divide the weight equally. The point where this weight is to be supported on the front system is readily located by finding the required lever arm to obtain the same moments in the rear of the center of the wheel base as those in front of it. This center may be called the virtual supporting point of the rear system on the front engine.

15 The weight on this point, multiplied by its distance from the center of the wheel base of the rear system, gives the moment for this system. By dividing the weight of the rear system into this moment, we find the distance from the wheel base center of that system at which its center of gravity must be located; as is graphically shown, with all moment curves in both systems, in Fig. 1. The balls in the figure represent the various weights so far as they effect the distribution, and their relative value is represented by their height from the base line. It is not necessary to include wheels, axles, and boxes or what are termed dead weight in this method of calculation, because they are all central over the supporting points; and, as shown in the figure, are added after the distribution of the live weight is ascertained. In Fig. 1, the curve to the right of the front wheel base center is the moment curve of that system. This curve is reproduced on the left of the center and will pass through the point where one-half of the distance between the two systems will balance that of the front system. Starting from this point, and with reference to the rear wheel base center, we get the moment curve for the rear system which passes through the center of gravity of that system where it intersects the level from the common base line, representing its total weight. All the moment curves are of course true hyperbolæ and are therefore easy to construct. An approximate plan is laid out and modified until the desired total weight is obtained; and,

if the center of gravity of the rear system does not coincide with this calculation of distribution, it is generally most convenient to shift the location of the boiler in the required direction until that occurs; or, if preferred, the framing and heavier castings in front and rear of the center of gravity may be modified to produce the same effect.

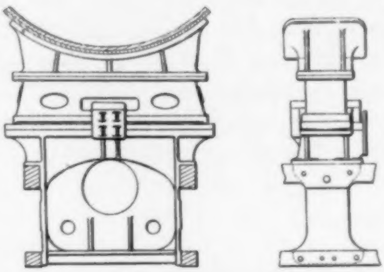

Fig. 2 Main Boiler Bearing

16 The support of the rear system on the front engine, shown in Fig. 2, must be capable of sliding laterally to allow the front engine to enter a curve and form an angle with the rear engine. For this reason the two engines are hinged together by vertical swivel pins located, preferably, slightly ahead of a point midway between the two wheel sets, because the swivel point being so located aids the

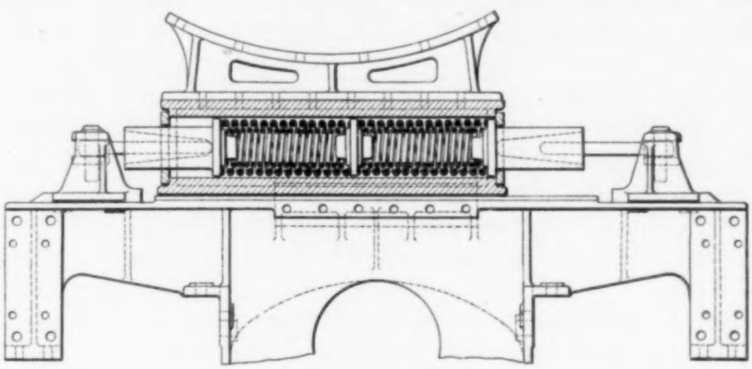

Fig. 3 Spring Centering Device

guiding of the rear engine into curves on account of its closer proximity to the center line of the track when the engine is going ahead. A lateral spring applied in the front part of the leading engine permits an elastic yielding of that engine into a curve and restores alignment in leaving it (Fig. 3).

17 It is not practical, however, to place the sliding support on the virtual location previously mentioned; because the front engine would then be unstable and tip one way or the other, like a scale beam, with the slightest disturbance due to change of weight on grades, but it should be on a convenient location in front of the virtual one. This, of course, would allow the front engine to tip forward as the imposed weight on that point would be less and the arm from the driving wheel base center, shorter. To correct this disturbance, a pair of vertical hanger bolts are applied between the upper member of the frame at the extreme rear end of the front engine and the lower member at the extreme front end of the rear frame (Fig. 4); or two supports may be provided, one on each side of the virtual supporting point. With these bolts or hangers, the

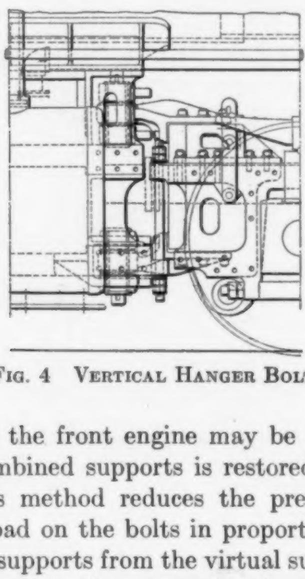

Fig. 4 Vertical Hanger Bolts

proper alignment of the front engine may be adjusted at will and the effect of the combined supports is restored to the virtual supporting point. This method reduces the pressure on the sliding plate and imposes load on the bolts in proportion to the respective distances of the two supports from the virtual supporting center.

18 It is evident that the supporting bearing must be self adjusting to bear evenly at all alignments of the engine. To accomplish this, the lower, or what we may call the pillow plate, has a ground surface on its upper side on which a corresponding upper plate can slide with the movement of the boiler; while its under side is slightly curved to allow a longitudinal rocking. This pillow plate is held in position by means of two dowel pins of about 2 in. in diameter recessed about $\frac{3}{4}$ in. into the plate and an equal amount down into the cross-tie on which it rests approximately in the middle of

the convex or curved part. In this way the pillow plate is kept in position without destroying its ability to adjust itself so as to present a uniform bearing for the upper or sliding plate at any alignment of the engine, as shown in Fig. 2.

19 The front engine thus becomes a very efficient leading truck for the rear engine. Opinions on the use of a truck in the articulated engine are, however, divided; but, because of the many objections connected with the application of a front truck in freight service as to the first cost, maintenance, dead weight and unfavorable distribution of the machinery sometimes causing serious obstructions, nothing is gained by this objectionable feature; as it is practically the same as putting a truck ahead of a truck.

20 The front engine in going ahead being a truck in itself, the first pair of drivers have a leverage in their favor in entering the curve. The reason for this is that the virtual support of the weight of the rear system, which is carried by the front, falls back on the latter and in the rear of the sliding bearing; thus allowing a great part of the load of the rear engine to be carried by the hanger bolts (Fig. 4) between the two frames.

21 This alone reduces the pressure very materially on the sliding plate, which together with the short arm for friction resistance and long guiding arm for the flanges, reduces the pressure on them to a small fraction of the total friction load on the sliding plate; and comparatively light centering springs will therefore suffice for this purpose and still further reduce the flange pressure.

22 These same leverages and resistances act equally favorably in backing; as it is simply a reversed operation and the rear drivers have to swing the boiler against these resistances. Therefore, it is important that these should be small and with the shortest possible leverages, which naturally also minimizes the flange pressure on the rear wheel; that is, the last wheel of the engine, which then has to do the guiding.

23 With the use of a front truck, the center of support is shifted forward and with it the virtual and actual supporting points of the weight of the rear engine carried on the front system. The weight on this support must, therefore, be increased with the carrying capacity of the truck and offer little or no opportunity for transferring any of this load to the hanger bolts, practically doubling both the load on the sliding plate and the length of the resistance arm. At the same time, by the application of a front truck, the guiding point is moved forward so that the leverage has been increased to offset

the increased side resistance of the engine. The guiding power of the truck, however, is limited to its swing resistance. This, therefore, may leave as much or more guiding to be done by the front drivers as where no truck is used because of the increased moments of resistance of the engine in curving.

24 A more serious matter, however, is the backing with a front truck. The high resistance moments in the front must be overcome by the rear drivers, which are doing the guiding, and it is easy to understand how fast the flange pressure is multiplied by this displacement of the load and the safety margin for derailing dangerously reduced. It is therefore evident that a rear truck is a necessity when a front truck is used where backing is to be considered; thus curing one evil with another. Even with the application of a rear truck, the objections caused by the application of the front truck will be only partly compensated for; as the following very essential objections still remain:

a The application of a front truck increases the distance of the front buffers from the first pair of drivers by 15 to 20 per cent, and consequently throws the front drawhead of the engine further out from the center of the track incurves than with the shorter extensions where no front truck is used.

b It increases the total wheel base of the engine about 8 ft. 6 in., requiring an 80-ft. turn table to take an average sized engine with its tender.

c Additional dead weight to be carried by the truck must be provided and the expenses in maintenance and first cost by the use of it are items that should not be overlooked.

d The long arms for friction resistances on the sliding plate with increased load on them, due to the front truck, will not be lessened by the application of a rear truck.

e When only a front truck is applied, the boiler is necessarily moved so far forward that it leaves scant room for the valve motion on the rear engine. The result of this is that the width of the firebox is necessarily limited to about 72 in.

25 In the case of passenger engines of the articulated type, however, large wheels would be used, and only four pairs of drivers can or need be applied. A four wheel front truck, with rigid center pin and rigid trailing wheels, work in conveniently in the place of a third

pair of drivers in each engine front and rear, respectively; which otherwise with their large diameter, make the engine unduly long.

26 Continuing with the construction of an engine without a truck, the spring rigging and equalization are next to be taken into consideration. The springs are most conveniently located above the boxes and frame, except under the firebox where they must be placed between the adjacent wheels with yokes over the boxes in the usual manner. On the front engine, all springs on each side are equalized together with a cross equalizer between the front springs. The rear engine is equalized in the same manner, except that the cross equalizer is omitted. This makes a three-point suspension of the whole engine and prevents any excessive local stresses of a diagonal nature on an uneven road; as the front engine accommodates itself very

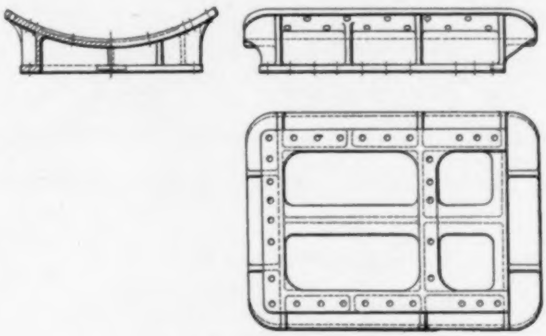

Fig. 5 Boiler Saddle

freely to the rear engine and approximately divides the angularity between the inclination of the axles. The wheels then follow the rail comparatively freely and easily on the twisting parts; at the rising of the outer rail; on entering and leaving curves; as well as on any other unevenness of the road.

27 The high pressure cylinders, as previously stated, are located under the cylindrical part of the boiler, generally slightly in the rear of the middle of the barrel. They are provided with a cast steel saddle, bolted or riveted to the shell of the boiler by its upper flange and to the cylinder half saddle by its lower flange as shown in Fig. 5. The cylinder saddles, however, are not divided in the center of the engine; but sufficiently to one side to allow the receiver pipe with its ball joint to be placed in the center line of the engine (Fig. 6).

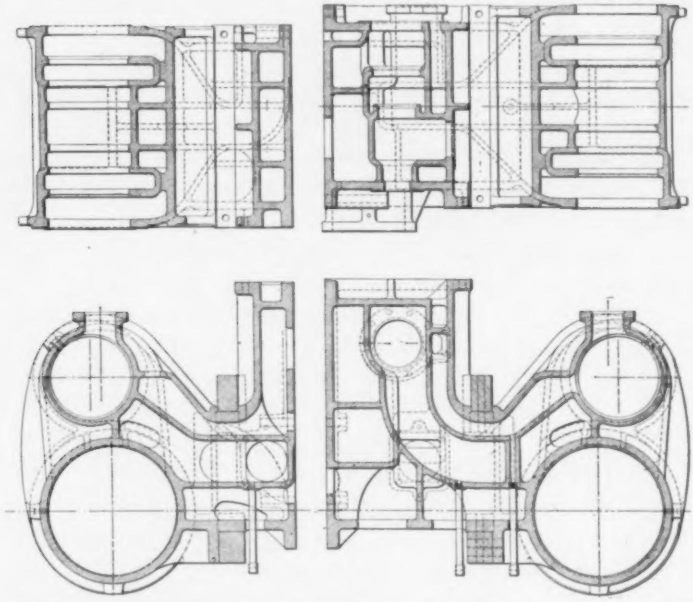

FIG. 6 CROSS SECTIONS OF RIGHT AND LEFT HAND HIGH PRESSURE CYLINDERS

FIG. 7 CROSS SECTION, FRONT AND PLAN VIEWS OF LOW PRESSURE CYLINDERS

28 The low pressure cylinders, Fig. 7, are fixed to the front engine with so-called "half saddles" but not connected to the boiler; except by the flexible exhaust pipe. With the large low pressure cylinders required for the desired power, there will naturally be con-

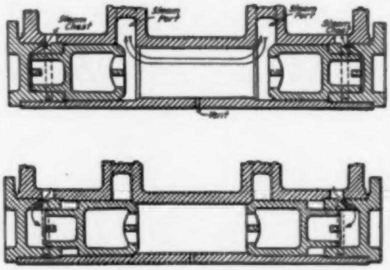

FIG. 8 BY-PASS VALVES

siderable suction of cold air through the cylinders in running with the steam shut off; which is very objectionable for several reasons, one of which is the sudden cooling of the cylinder walls and passages.

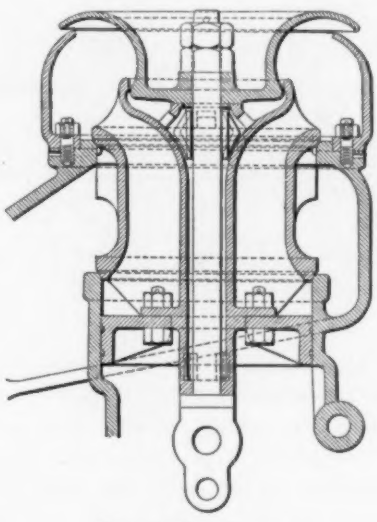

FIG. 9 THROTTLE

To obviate this, a pair of by-pass valves (Fig. 8) are located in the cylinder castings. These valves automatically open communication between both ends of the cylinder when the throttle is closed, so

that a certain amount of air can circulate through this passage to and fro with the movement of the piston, and thereby prevent the sudden changes in the temperature and relieve the pumping of air through the exhaust nozzle, and also minimize unnecessary agitation of the fire.

29 The steam enters the high pressure cylinders directly from the dome, where the throttle is located, as usual, and it exhausts into the high pressure cylinder saddles on each side and meets at a point where the steam enters the intercepting valve. After passing through into the receiver pipe placed in the center of the front engine at a

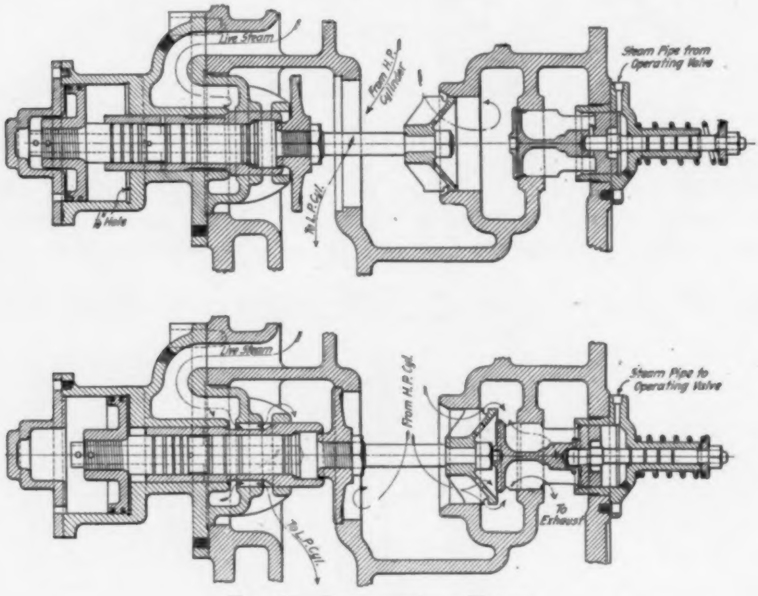

FIG. 10 INTERCEPTING VALVE

convenient height above the axles, it branches off through a "Y" pipe to each of the low pressure cylinder saddles and through passages in these saddles to the steam chest. The exhaust from the low pressure cylinders returns through the saddles and meets in a pipe delivering to the common exhaust pipe and the stack.

30 In order to obtain high efficiency and emergency power, various special details that may be of interest have been brought into use in these designs.

31 The throttle shown in Fig. 9 is provided with a steam separator at the extreme top, where the steam enters in an upward direc-

tion; and, after entering, meets a sharp turn downward whereby the entrained water is thrown against the curved walls of the crown, is entrapped at its base and forced down through a central passage back to the boiler by the inertia exerted in the trap. The continuous current of moisture that is abruptly arrested allows no chance for the water particles, once brought into contact with the curved wall of the crown, to escape the trap. The steam in relieving itself from the moisture makes the turn into the valve opening directly at the top and through the valve body to the lower opening as will be seen from the cut.

32 Following the course of the steam, we do not meet any unusual construction of the passages until we reach the intercepting valve which, although not specially designed for this engine, should be considered in this connection as a most important factor; as it controls the pressure for the receiver and low pressure cylinders, supplies steam direct from the boiler at a proportional pressure to the large cylinders in starting, prevents this pressure backing up against the high pressure piston and makes it possible to increase the

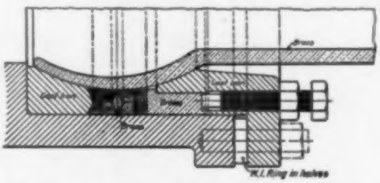

Fig. 11 Receiver Pipe Ball Joint

power of the engine about 20 per cent at critical moments, by permitting the engine to be changed in such emergencies so as to work live steam in all cylinders with equivalent distribution of the work. With the exception of changing the engine into simple while under way, all its movements are automatic (Fig. 10).

33 The intercepting valve consists principally of two valves intimately combined; the one effecting the closing of the other; and a change valve by which the former is unbalanced in turning the engine into simple working when under way. The main valve closes the receiver and prevents the reduced live steam pressure from backing up against the high pressure piston in starting and working simple, and by closing the exhaust valve the accumulation of exhaust from the high pressure cylinders automatically opens the main valve to the low pressure side of the receivers and simultaneously closes the admission and reducing valve, whereby the engine is changed into compound.

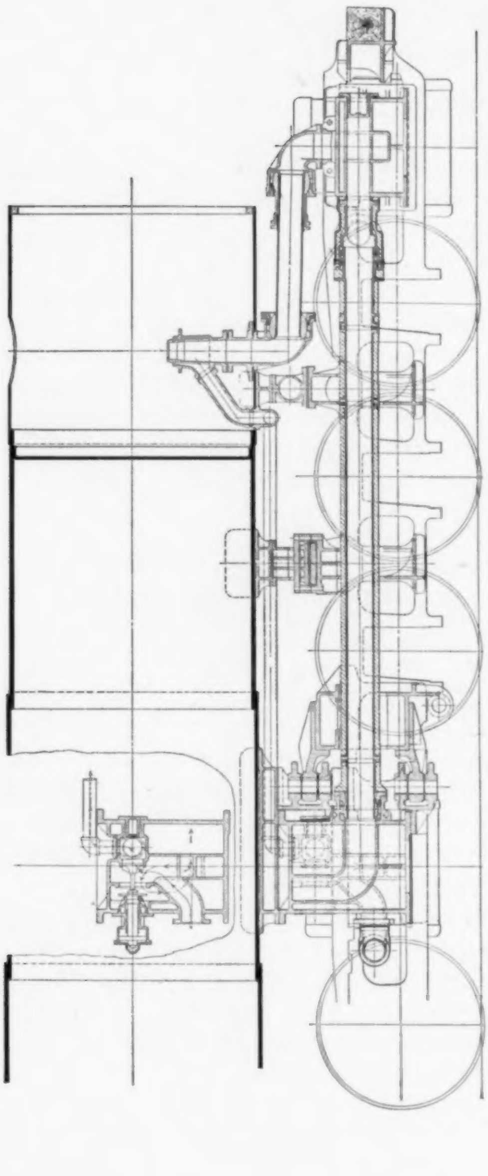

FIG. 12 CENTRAL LONGITUDINAL SECTION FROM HIGH PRESSURE CYLINDER TO LOW PRESSURE CYLINDER, SHOWING STEAM PIPES

34 The live steam admission and reducing valve has the form of a sleeve placed on the stem of the main valve; and, as seen in the cut, is allowed a limited longitudinal play to perform its double function.

35 The third, or change valve, has two functions to perform and is operated by the engineman in emergencies; and is, therefore, known as the emergency valve. Its use is resorted to only when the engine is about to stall on a heavy grade or at a difficult starting place. The first function of this valve is to unbalance the intercepting and reducing valves so that the former cuts off the low pressure side of the receiver; and the second function is that of an outlet valve for high pressure cylinder exhaust steam in working simple, which later is led in an independent pipe to the stack.

36 The next features of importance are the ball joints in the receiver and exhaust pipes which are peculiar to this type of engine. They consist (Fig. 11) of ball bearings, gland and packing. The latter is made of eight $\frac{1}{2}$ in. square rings of Vulcabeston or fibrous packings laid in pairs, in the middle of which a brass ring of an elongated diamond section is inserted. Being just the width of the packing space, this ring seals all joints in the packing rings proper and forces them tightly against the inside of the box and against the ball. The receiver pipe, with the ball joint and its location, and the exhaust pipe are shown in Fig. 12.

37 The flexible exhaust pipe has two ball joints and one slip joint; as it is subject to a greater angle of deflection and elongation than the receiver pipe, which has its ball joint in the vertical center line of the pivot pin between the two sets of engines.

38 The valve motion in each set of engines is of the Walschaert type, driven by their respective main axles and crossheads and operated with a common reversing gear which simultaneously changes the motions of all the valves. Because of the lateral motion of the front engine in curving, means must be provided for flexibility in the operating gear so that this movement does not interfere with the motion of the valves. This is accomplished by using an exceptionally long lifting link, shown in Fig. 13, having a double jaw in its upper end and a universal joint or ball bearing at the radius bar, which allows its lower end to follow the movement of the engine transversely relatively to the rear engine, as well as the longitudinal movement of the valve in any angularity of the engine within the required limit of the swing.

39 The valve gear is operated by a hydro-pneumatic reversing

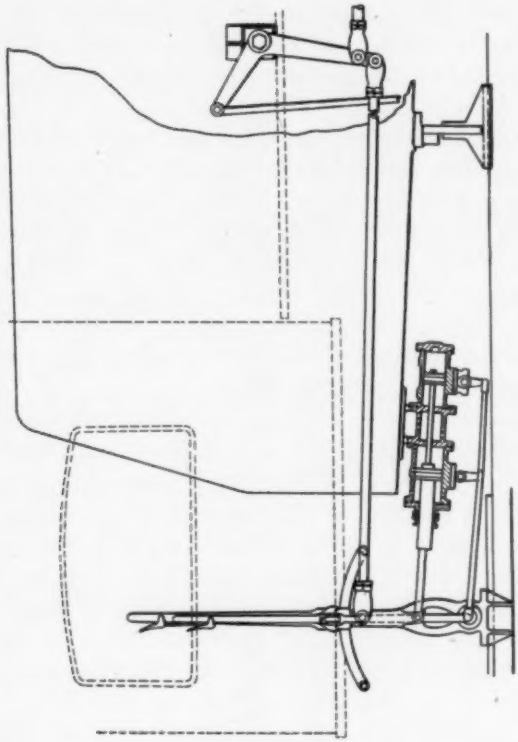

FIG. 14 REVERSE LEVER ARRANGEMENT

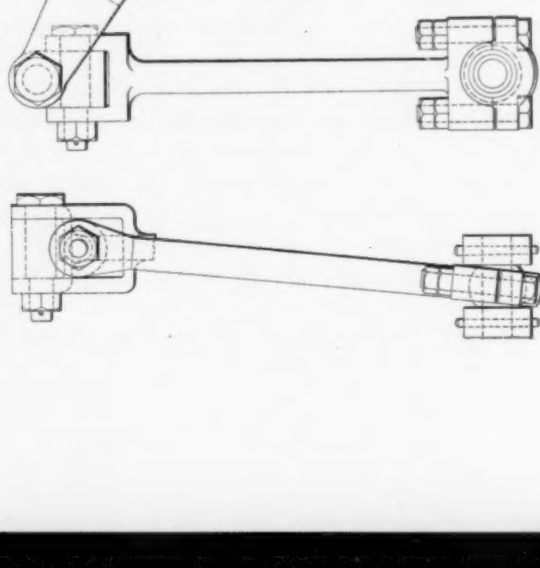

FIG. 13 RADIUS BAR LIFTER

mechanism, Fig. 14 and 15, consisting of one air and one oil cylinder, with the common piston rod connected to the main reversing lever. On a suitable location on the *main* lever is pivoted a second lever for operating the gear.

40 A forward movement of this lever throws its lower end backward, turning the valves of the air and oil cylinder (shown in Fig. 15), thus making communication with the rear end of the air cylinder for air pressure to force the piston forward and, with it, the entire gear. The oil cylinder serving as a lock and regulator has, by this movement, established communication between both sides of its piston, allowing the latter to follow the movement of the gear to which it gives a moderate and uniform motion because of the contracted passage for the oil through the valve. By stopping the

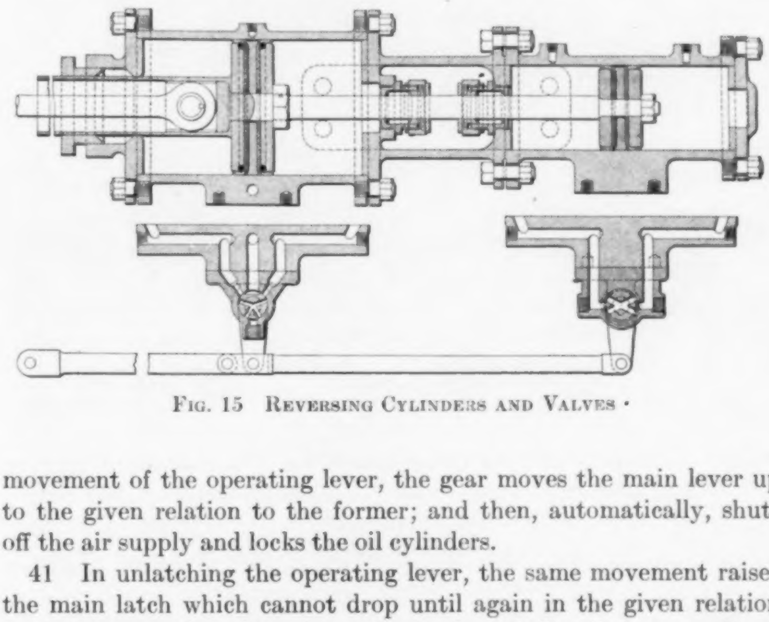

FIG. 15 REVERSING CYLINDERS AND VALVES

movement of the operating lever, the gear moves the main lever up to the given relation to the former; and then, automatically, shuts off the air supply and locks the oil cylinders.

41 In unlatching the operating lever, the same movement raises the main latch which cannot drop until again in the given relation to the former, when the valves of both air and oil cylinders are closed and a positive locking of the gear is secured in addition to that of the oil lock. The handle part of the main lever is made for the purpose of operating the engine by hand in the absence of air pressure or any disorder of the gear.

42 These illustrations show only a few parts peculiar to this special type of locomotive as ordinarily constructed by the American

Locomotive Company. These locomotives have proved very satisfactory in every respect, and have practically become a standard with these builders, but are of course subject to variations as may suit various service conditions.

43 The most striking variation in any of these details is probably the intermittent draft coupling of this type of locomotive turned out by the Baldwin Locomotive Works, shown in Fig. 16, where a lateral play is provided for, and the draft pin is held in a central position by a series of springs. With the exception of some articulated engines built by them for service in Porto Rico in 1904, the first of this type

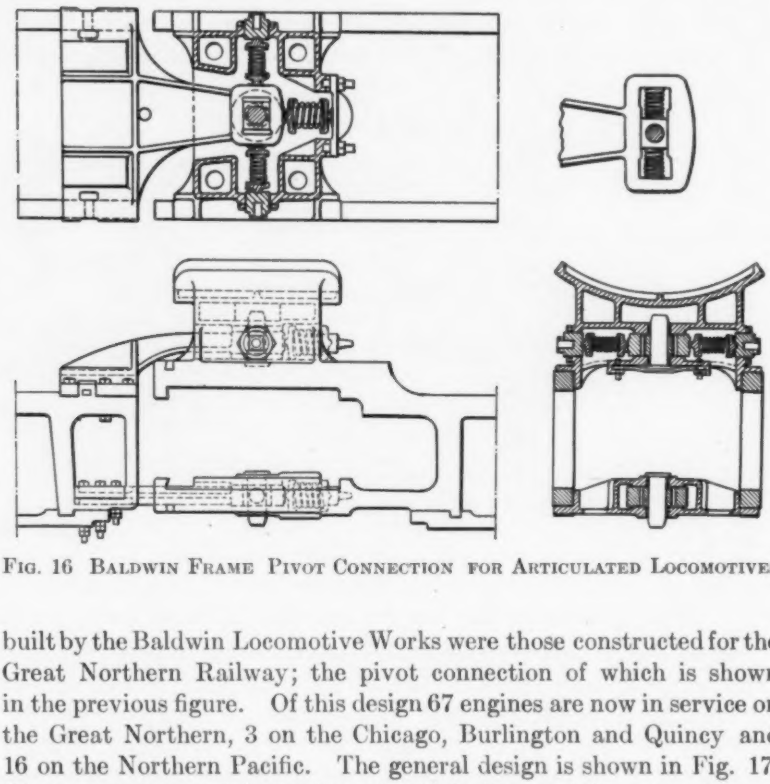

FIG. 16 BALDWIN FRAME PIVOT CONNECTION FOR ARTICULATED LOCOMOTIVES

built by the Baldwin Locomotive Works were those constructed for the Great Northern Railway; the pivot connection of which is shown in the previous figure. Of this design 67 engines are now in service on the Great Northern, 3 on the Chicago, Burlington and Quincy and 16 on the Northern Pacific. The general design is shown in Fig. 17. These engines are giving universal satisfaction and the present number is the result of repeat orders without any change whatever in design.

44 The above mentioned builders have also excluded the use of by-pass valves, double ported slide valves, and the intercepting valve

in their cylinder construction, the starting being effected by simply letting live steam into the receiver.

45 The question of superheating the steam in connection with this type of locomotive has been considered practically from the outset. Superheating would further increase the efficiency of the engine, but it has so far been deemed advisable to leave it off to avoid complications until this type becomes more generally known.

46 Fig. 18 illustrates a design of Mallet locomotive prepared in accordance with instructions from Mr. Kendrick, Vice-President of the Atchison, Topeka and Santa Fé Railroad, now being constructed under his patents by the Baldwin Locomotive Works. In this design the combustion chamber which is also fitted with superheater device is used.

47 Among the various differences between this class of engines and that of the ordinary type, is the action of this engine when loaded to the slipping point. While the former is less liable to slip than the latter, due to a more uniform pressure on the pistons, they will not be considered loaded to anywhere near their capacity until slipping takes place, and consequently slipping does occur on heavy grades. With the ordinary engine, slipping at such times is a serious matter, as the train is losing speed and may stall on that account after a few repetitions. In the case of the articulated engines, the loss in power by the slipping of one engine is practically gained by the other, in the increase of unbalanced pressure that thereby results. This difference in the unbalanced pressure has the opposite effect on the slipping engine, usually causing it to stop slipping after a few revolutions, without the necessity of closing the throttle. This is explained by the fact that, when the low pressure engine slips, the receiver pressure naturally falls and reduces the back pressure on the high pressure piston, as well as the forward pressure on the low pressure piston; causing the latter engine to stop slipping on account of the friction against the rail under the reduced receiver pressure, which reduction also increases the average unbalanced pressure on the high pressure piston a corresponding amount.

48 When the high pressure engine begins to slip, the receiver pressure increases by the more rapid supply of steam, and with this the back pressure on the high pressure piston is increased, causing this latter engine to resume its grip on the rail and increasing the power of the low pressure engine until the normal power is restored in the high pressure engine.

49 It is further to be noticed, that a simultaneous slipping of both

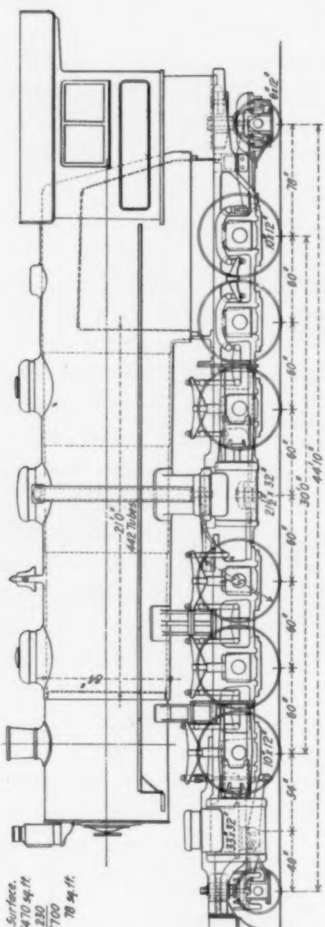

FIG. 17 ELEVATION OF ARTICULATED LOCOMOTIVE FOR THE GREAT NORTHERN
BALDWIN LOCOMOTIVE WORKS, BUILDERS

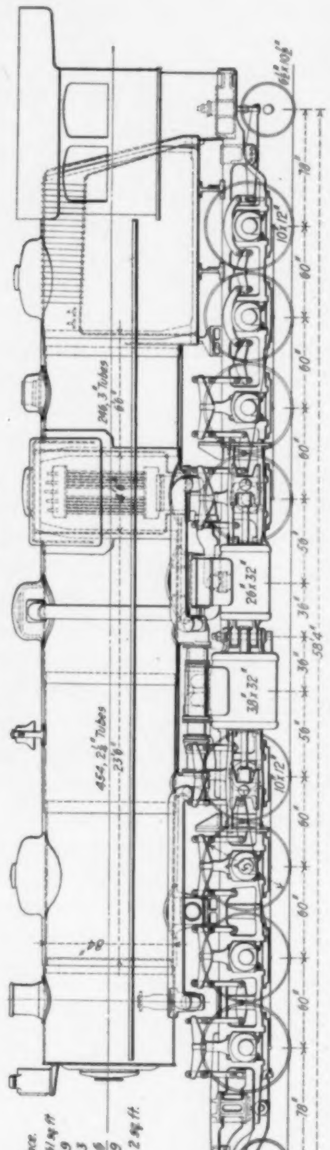

FIG. 18 ELEVATION OF ARTICULATED LOCOMOTIVE BUILDING FOR THE ATCHISON, TOPEKA AND SANTA FÉ RAILROAD
BALDWIN LOCOMOTIVE WORKS, BUILDERS

engines is a very rare occurrence; due to the fact that there is one position of the crank where the turning effort is greater than in other positions, and this is where the slipping generally starts at irregular intervals of revolutions, depending on the condition of the engine as necessity for repairs. If the wheels are of a very close approximation to the same diameter and running on a straight track, these intervals are longer, because the opposition between the wheels requiring readjustment is less frequent than when the wheels are unevenly worn. In either case, there is the greatest liability for this adjustment in the neighborhood of the greatest turning movement; say every fourth or fifth revolution, on a normal rail condition. Being two independent engines, the coincidence of these conditions is very infrequent. The slipping of one engine may follow that of the other due to the temporary increase in power; but one is seldom found to start slipping, before the other has stopped slipping; and it can, therefore, be said without much exaggeration, that this type of engine is, in effect, a non-slipping engine.

50 When working live steam in all cylinders, generally known as working simple, the slipping is even less perceptible, although over 20 per cent more power is developed; because the live steam supply to the low pressure cylinders and the direct exhaust fr6m the high pressure cylinders are restricted to a very moderate piston speed. From the beginning of the slip, the low pressure piston gets a rapid motion which causes a sudden fall in the pressure and the slip generally stops after a few inches movement of the piston under normal weather and rail conditions. The restricted supply port being fully open, however, the pressure is restored practically simultaneously with the stopping of the slipping.

51 The high pressure engines are not so sensitive; but after a couple of exhausts under slipping, the wheels regain their grip on the rail with comparatively small loss of power and in a period of short duration.

52 The effect on cars and draft gears in starting heavy trains by this type of engine, as well as convertible compound engines on the same principle, is a most important feature, as it is accomplished with a so-called dead pull, without the necessity of taking advantage of the slack in the train with its destructive jerks. These locomotives are, therefore, easier on the draft gears than simple engines of half their size loaded to their full capacity. The reason for this is found in the great starting and emergency power, previously referred to, with which these engines are provided, so that the slack

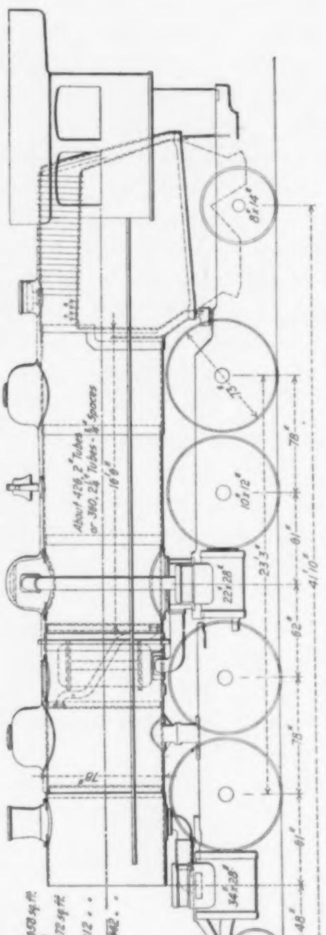

FIG. 19 BALDWIN WORKS' PROPOSED DESIGN OF ARTICULATED PASSENGER LOCOMOTIVE FOR THE ATCHISON, TOPEKA AND SANTA FÉ RAILROAD

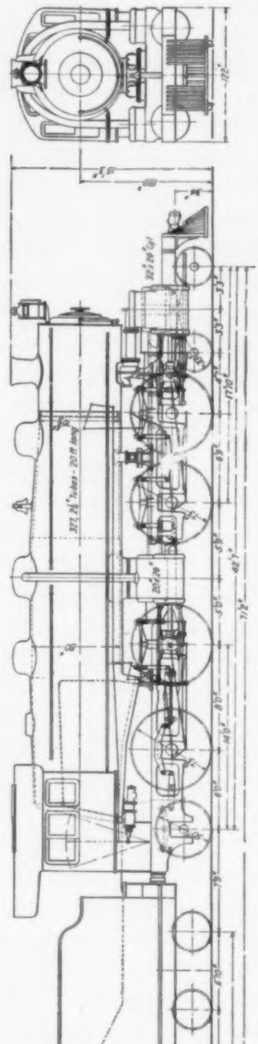

FIG. 20 AMERICAN LOCOMOTIVE COMPANY'S STUDY OF ARTICULATED PASSENGER LOCOMOTIVE

is taken up under very slow speed. This is generally done with light throttles. The front cars start successively under a slight acceleration of the engine, gradually going over to a retardation before the last cars get into motion, after which the engine is given full throttle. In other words the train is stretched first and then it is started under direct pull, so that there need not be any but slight shocks or jerks.

53 These engines are adaptable to a greater variety of conditions than the older types, rendering it possible to double the engine power on a given rail weight; and their advantages are most pronounced as displayed on heavy grades and sharp curvatures.

54 Over a hundred locomotives of this type have been built up to the present date in this country, ranging in weight on drivers from from 106 000 lb. to 410 000 lb. and from 20000 lb. to 125 000 lb. in tractive power. The largest of these is taking the place of three ordinary sized locomotives, in pushing service, and is doing its work very satisfactorily.

55 Their success in freight service will undoubtedly lead to their adoption in passenger service; especially in certain localities to avoid double heading, as the Pacific type locomotive is practically the upper limit for one set of drivers. It, therefore, appears that further development will have to be in the flexible driving wheel base or articulated type.

56 Fig. 19 shows a design of Mallet type locomotive for passenger service, fitted with re-heater between the high and low pressure cylinders and feed water heater in combination therewith, prepared by the Baldwin Locomotive Works for the Atchison, Topeka and Santa Fé Road. Engines of this design are now under construction at the Baldwin Works.

57 An American Locomotive Company's study of an articulated passenger locomotive is shown in Fig. 20, which is a preliminary diagram of a 4442 class. Neither the front truck nor the trailer has any side motion beyond their ordinary axle play because the individual wheel bases would be too short to guide this engine safely, without the rigidity of the truck and trailer. The truck, however, has a rigid center pin around which it can adjust itself in a curve without restriction by the alignment of the engine.

58 It should also be remarked that, due to absence of jerks and slack in starting, as well as the more uniform cylinder pressure, the stresses on the machinery and framework are considerably reduced; and, further, that the milder exhaust produces a less intense heat

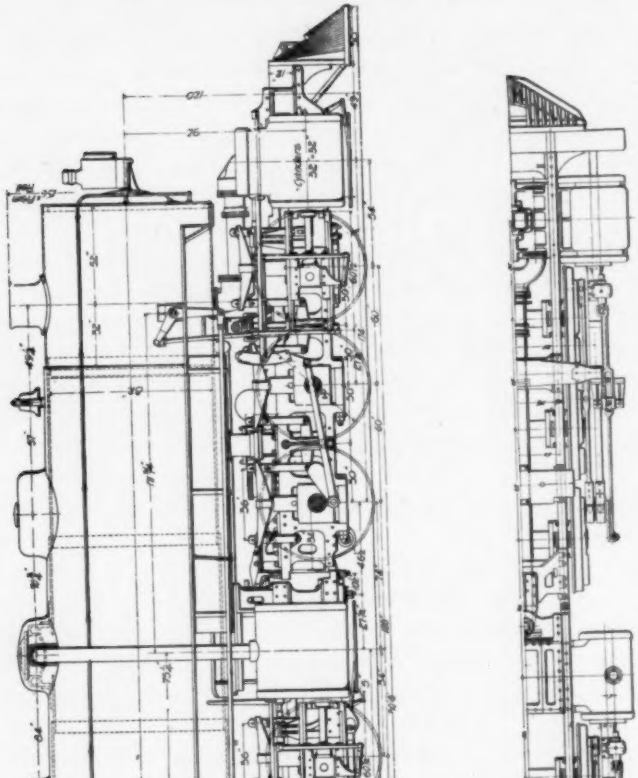

FIG. 21 ELEVATION AND HALF PLAN OF ARTICULATED LOCOMOTIVE FOR BALTIMORE & OHIO RAILROAD
AMERICAN LOCOMOTIVE COMPANY, BUILDERS

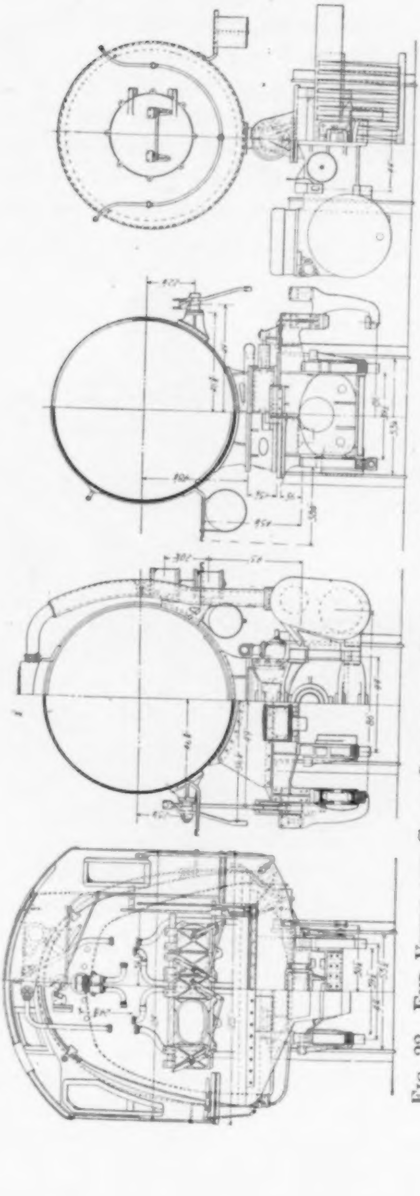

FIG. 22 END VIEWS AND CROSS SECTION OF ARTICULATED LOCOMOTIVE FOR BALTIMORE & OHIO RAILROAD
AMERICAN LOCOMOTIVE COMPANY, BUILDERS

and a better utilization of it, all of which contribute to a reduction in the repairs of the locomotive as a whole, compared with a simple engine, if it were practical to construct one of this type. This has never been advanced as a feature to the credit of the articulated engine because it is difficult to give it any definite value; but is referred to as a reply to the often repeated supposition that these engines are hard to keep in repair. As a matter of fact the opposite is the case because on account of the subdivision of the work in two engines the parts are lighter and easier to handle in repairs and renewals.

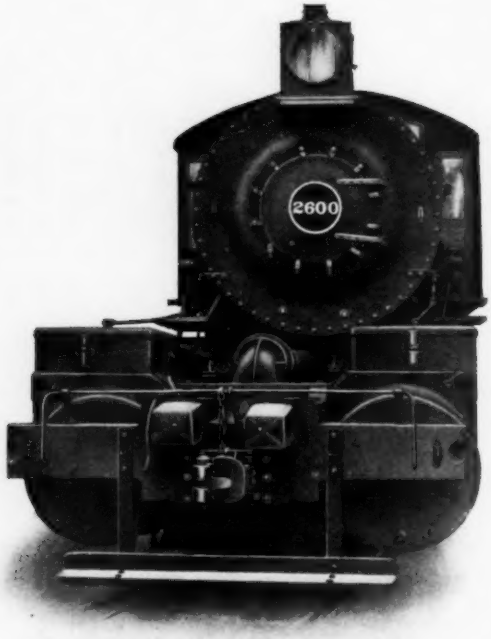

Fig. 23 Front End View of Articulated Locomotive Rounding a Curve

59 One of the fundamental principles in locomotive engineering, as applied to conditions as they exist in the United States, is simplicity of construction. This has led to a general reluctance on the part of American railroad officials to accept complications as long as they could avoid it. The tendency toward heavier trains has, however,

made it necessary to supply units of larger hauling capacity than have heretofore been necessary anywhere in the world. For the most exacting freight service, locomotives are required which have entirely outgrown the possibilities of ordinary construction; in very much the same way as marine requirements have outgrown the types of propelling engines, which were entirely satisfactory a generation ago. In fact, the demand for units of large power compels special construction; in order that the large units may be operated without damage to the track and structures, and to avoid increasing the size of the moving parts of the locomotive to a prohibitive point.

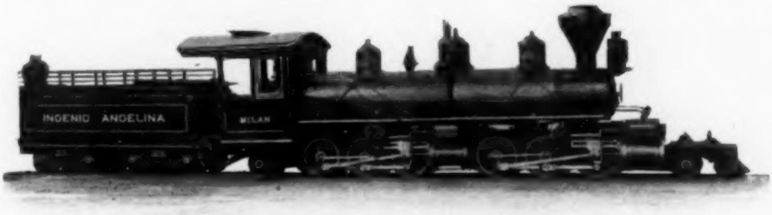

FIG. 24 SMALL ARTICULATED LOCOMOTIVE
BUILT FOR THE INGENIO ANGELINA BY THE BALDWIN LOCOMOTIVE WORKS

Gage	2 ft. 6 in.	Diam. Drivers	33 in.
Diam. Cyl.	H. P. 10 in. L. P. 15 in.	Wt. on Drivers	51 000 lb.
Stroke	16 in.	Total Wt.	60 200 lb.
Pressure	180 lb.	Tractive Power	11 630 lb.

60 The articulated locomotive represents the highest development in this branch of engineering; and the development is sufficiently important to justify the presentation of the subject in its present stage before a body of engineers who have had much to do with corresponding developments in stationary or marine practice.

61 For the data and illustrations contained in this paper, the writer wishes to express his indebtedness to the American Locomotive Company and to Mr. Samuel Vauclain, General Manager of the Baldwin Locomotive Works.

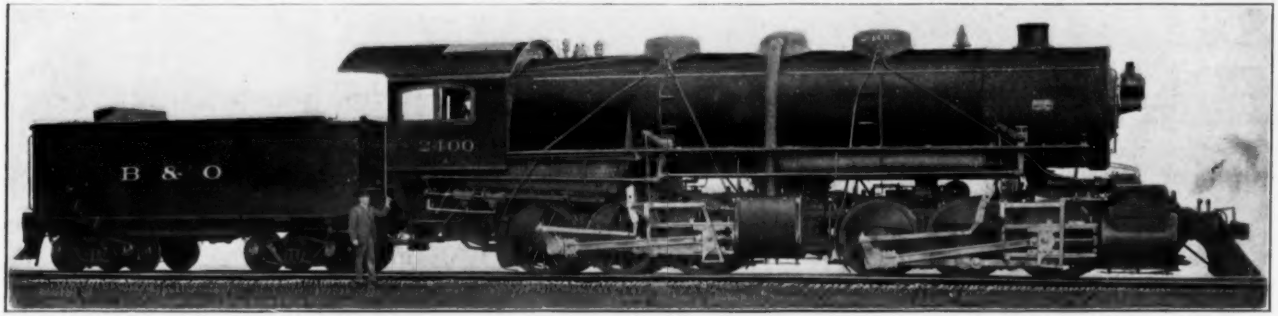

FIG. 25 THE FIRST MALLET ARTICULATED COMPOUND LOCOMOTIVE BUILT IN AMERICA

BUILT FOR THE BALTIMORE AND OHIO RAILROAD BY THE AMERICAN LOCOMOTIVE COMPANY

Gage of track	4 ft. 8½ in.	Outside diameter of tubes	2¼ in.
Diameter of cylinders	h.p. 20 in.; l.p. 32 in.	Length of tubes	21 ft.
Stroke of piston	32 in.	Driving wheel base	30 ft. 8 in.
Diameter of driving wheels	56 in.	Rigid wheel base	10 ft.
Outside diameter of boiler at front end	84 in.	Total weight in working order	334 500 lb.
Working pressure	235 lb.	Weight on driving wheels	334 500 lb.
Length of firebox	108 in.	Tractive power	71 500 lb.
Width of firebox	96 in.	Tractive power working simple	91 000 lb.
Number of tubes	436	Factor of adhesion	4.67

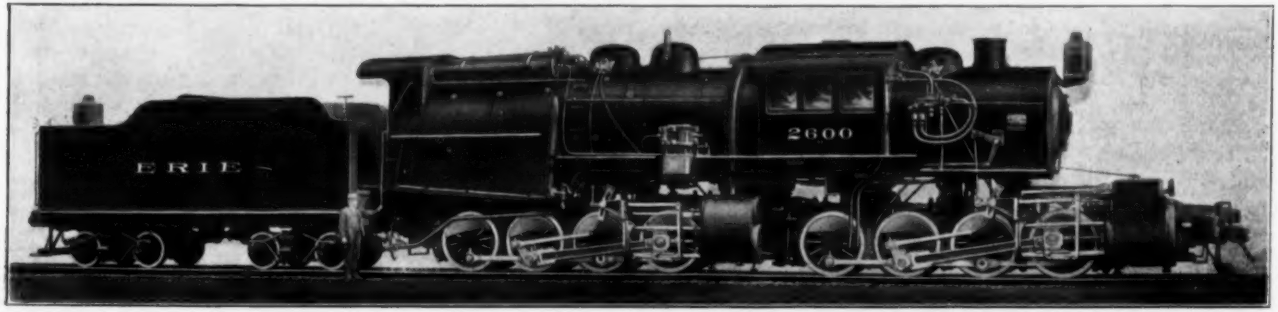

Fig. 26 Heaviest and Most Powerful Locomotive in the World

MALLET ARTICULATED COMPOUND LOCOMOTIVE BUILT FOR THE ERIE RAILROAD BY THE AMERICAN LOCOMOTIVE COMPANY

Gage of track	4 ft. 8½ in.	Outside diameter of tubes	2¼ in.
Diameter of cylinders	h.p. 25 in.; l.p. 39 in.	Length of tubes	21 ft.
Stroke of piston	28 in.	Driving wheel base	39 ft. 2 in.
Diameter of driving wheels	51 in.	Rigid wheel base	14 ft. 3 in.
Outside diameter of boiler at front end	84 in.	Total weight in working order	410 000 lb.
Working pressure	215 lb.	Weight on driving wheels	410 000 lb.
Length of firebox	126 in.	Tractive power	94 800 lb.
Width of firebox	114 in.	Tractive power, working simple	120 000 lb.
Number of tubes	404	Factor of adhesion	4.33

This engine is equipped with boiler fitted with combustion chamber.

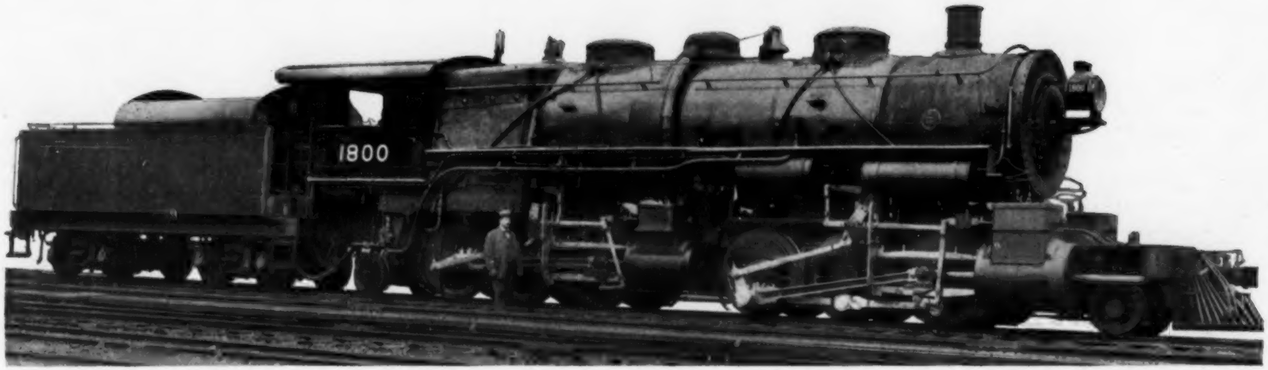

FIG. 27 MALLET ARTICULATED COMPOUND LOCOMOTIVE BUILT FOR THE GREAT NORTHERN RAILWAY

BY THE BALDWIN LOCOMOTIVE WORKS

Gage of track	4 ft. 8½ in.	Outside diameter of tubes	2¼ in.
Diameter of cylinders	h.p. 21½ in.; l.p. 33 in.	Length of tubes	21 ft.
Stroke of piston	32 in.	Driving wheel base	30 ft.
Diameter of driving wheels	55 in.	Rigid wheel base	10 ft.
Outside diameter of boiler at front end	84 in.	Total weight in working order	355 000 lb.
Working pressure	200 lb.	Weight on driving wheels	316 000 lb.
Length of firebox	117 in.	Tractive power	71 600 lb.
Width of firebox	96 in.	Factor of adhesion	4.41
Number of tubes	441		

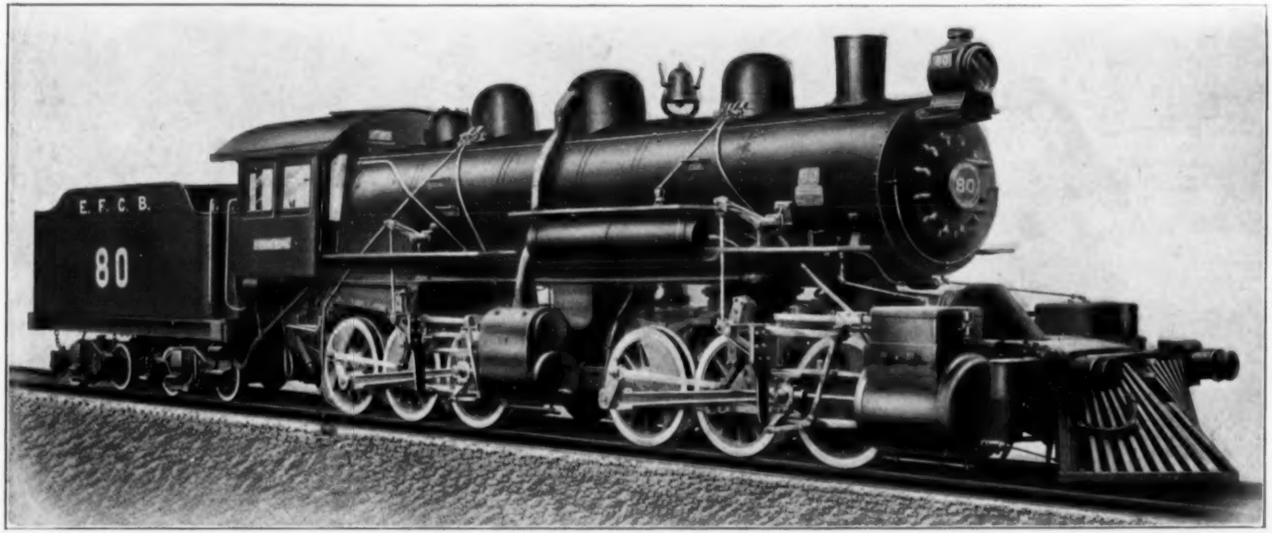

FIG. 28 MALLET ARTICULATED COMPOUND LOCOMOTIVE BUILT FOR THE CENTRAL RAILWAY OF BRAZIL

BY THE AMERICAN LOCOMOTIVE COMPANY

Gage of track	5 ft. 3 in.	Outside diameter of tubes	2 in.
Diameter of cylinders	h.p. 17½ in.; l.p. 28 in.	Length of tubes	18 ft.
Stroke of piston	26 in.	Driving wheel base	27 ft. 8 in.
Diameter of driving wheels	50 in.	Rigid wheel base	9 ft.
Outside diameter of boiler at front end	64 in.	Total weight in working order	206 000 lb.
Working pressure	200 lb.	Weight on driving wheels	206 000 lb.
Length of firebox	90 in.	Tractive power	42 400 lb.
Width of firebox	65 in.	Tractive power, working simple	52 000 lb.
Number of tubes	234	Factor of adhesion	4.86

UNNECESSARY LOSSES IN FIRING FUEL OIL AND AN AUTOMATIC SYSTEM FOR ELIMINATING THEM

By C. R. Weymouth, San Francisco, Cal.

Member of the Society

Practically all oil-fired boiler plants in stationary practice are subject to hand control throughout. It is customary to maintain a uniform oil pressure at the oil pump and in the oil pressure main, and to throttle the supply of oil by hand at all of the individual burners It is also customary to operate with full boiler steam pressure on the main suppplying steam to all the burners, and to regulate by hand the supply of steam for atomizing purposes, at each of the individual burners. Boiler dampers also are all subject to hand control on the individual boilers.

2 In a central station having say twenty 500-h.p. boilers there would be about 60 burners. For economy of labor, there would probably be not more than two or three firemen to the shift, in a plant of this size. On a commercial railway or lighting load subject to the usual fluctuations, such a plant would probably be operated with the rear boiler dampers clamped in fixed positions, wide open or nearly so. The supply of steam to burners would receive little attention, but the supply of oil to the burners would be regulated for variations in load by throttling to the extent necessary for maintaining the desired steam pressure. In such a plant there would be a more or less uneven rate of firing at the various boilers, and an excess of air for combustion at all loads, particularly at the lighter ones corresponding to a nearly uniform rate of flow of air through the furnace. The operators are likely to become careless, not noticing the drop in steam pressure with a sudden increase in load until this has become considerable, necessitating a severe momentary rate of firing in a number of boilers to bring the steam pressure back to

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the normal. This severe duty increases the expense for repairs to the boiler settings, rate of burning out of tubes, etc.

3 In certain plants where engineers are enlightened as to the principles of combustion, the attempt is frequently made to operate on a reduced air supply, with the result, if the dampers are set for mean or nominal load, that the chimneys smoke excessively on overloads before the limited number of firemen can reach all the dampers to open them.

4 As the lamentable result of these conditions, the average boiler plant efficiency with crude oil, even with the best types of boilers, averages much nearer 70 than 80 per cent, which is possible in large plants under proper methods of control.

5 Probably it will always be impossible to instill into the mind of an ordinary fireman such knowledge of the principles of combustion and the losses due to excess air supply, as to obtain economical results in large stations where it is necessary to depend on hand firing. Improved conditions can be secured by the employment of a boiler room engineer whose duty it is to scrutinize all fires from time to time and to coach the firemen in their duties; but the only ideal method seems to be an automatic system of control, such as will be here described, where the various adjustments, having once been made for economical conditions, are automatically repeated for the various conditions of load, maintaining a high average economy from month to month. With well-designed oil furnaces and careful adjustment under uniform load conditions, carefully conducted tests have shown that it is possible to obtain high percentages of CO_2, indicating as low as 10 per cent excess air over the requirements for perfect combustion, with no unconsumed elements in the flue gases.

6 Numerous data relating to coal fuel are available, showing the importance of reduced air supply as tending to high furnace efficiency; also the relation of excess air supply to any observed percentage of CO_2 and other factors of gas analysis. As few data for oil fuel are available, the following will be presented.

7 All Pacific Coast crude oils contain a certain amount of moisture, sulphur, nitrogen and oxygen; the main constituents being carbon and hydrogen. The characteristic difference in oils of different gravities lies in the relative quantities of carbon and hydrogen contained, there being more carbon and less hydrogen in the heavier oils, less carbon and more hydrogen in the lighter. In the better grades of oils treated at the wells before shipment, in which moisture has been largely eliminated, it can be roughly assumed that 3 per

cent of the oil is made up of sulphur, nitrogen, oxygen and water. This relationship is not universal, certain Southern California oils containing a large percentage of sulphur.

8 The predominating oil used on the Pacific Coast, known as Bakersfield oil, averages about 16 deg. Baume; which is equivalent to 336 lb. of oil per 42-gal. bbl. The ultimate analysis of this oil is about as follows:

Carbon, 85 per cent.	Nitrogen, 0.2 per cent.
Hydrogen, 12 per cent.	Oxygen, 1 per cent.
Sulphur, 0.8 per cent.	Water, 1 per cent.

A number of lighter oils in general use, ranging in the neighborhood of 18 to 20 deg. Baume, would average about as follows:

Carbon, 84 per cent.	Nitrogen, 0.2 per cent.
Hydrogen, 13 per cent.	Oxygen, 1 per cent.
Sulphur, 0.8 per cent.	Water, 1 per cent.

Certain heavier oils ranging from 12 to 14 deg. Baume average about as follows:

Carbon, 86 per cent.	Nitrogen, 0.2 per cent.
Hydrogen, 11 per cent.	Oxygen, 1 per cent.
Sulphur, 0.8 per cent.	Water, 1 per cent.

9 As a result of tests by Edmond O'Neill, Professor of Chemistry of the University of California, the calorific value of Bakersfield oil may be taken as about 18 600 B.t.u per lb., allowing for the presence of about 1 per cent moisture as indicated above. When corrected for moisture the net heat units per pound of oil are proportionally higher, although there is a slight loss in furnace efficiency due to the presence of moisture, inasmuch as all such water is evaporated into steam and superheated to the temperature of the escaping gases, involving an amount of heat both sensible and latent.

10 On the basis of the above analyses, the chemical requirements of air for complete combustion per pound of oil are as shown in Table 1.

11 In the various text books, the values given range from 16 to 18 lb. of air per lb. of oil, but an average of 14 lb. of air per lb. of oil is more nearly correct.

12 The ordinary method of indicating and measuring steam to atomize oil has been to express the quantity as a percentage of the

actual amount of water evaporated in the boiler. This percentage ranges from about 2 to 5 and over, depending on the system of oil burning, type of burner, etc. While such a percentage rating is no doubt convenient, it is inaccurate, in that the steam consumption of oil burners is proportional to the oil burned and not to the water evaporated. Various tests have shown that the steam consumption of oil burners ranges from 0.14 to over 0.5 lb. of steam per lb. of oil. The average value of good performance is about 0.3 lb. of steam per lb. of oil, although with hand regulation on variable load this quantity should be slightly increased, and is somewhat dependent on the gravity of the oil, temperature at the burners, etc. In stationary practice, the use of air for atomizing purposes has been practically abandoned.

TABLE 1 WEIGHT OF AIR REQUIRED FOR COMBUSTION OF OIL OF DIFFERENT GRADES

Grade of oil	Light	Medium	Heavy
Per cent of C	84.00	85.00	86.00
Per cent of H	13.00	12.00	11.00
Per cent of S	0.80	0.80	0.80
Per cent of N	0.20	0.20	0.20
Per cent of O	1.00	1.00	1.00
Per cent of H_2O	1.00	1.00	1.00
Calculated air per pound of oil chemically required—pounds	14.25	14.02	13.79
Corresponding maximum per cent CO_2 by volume—dry gases of combustion, per cent	15.16	15.52	15.89

13 As no direct experiments have been made showing the loss in boiler efficiency due to various percentages of excess air supply, the writer will present some simple calculations showing the amount of this loss.

14 It is well known that the loss due to an excess of air supply is not only on account of the direct loss in heating the added air to the temperature of the flue gases, but there is a secondary loss due to the fact that corresponding to an excess of air, there results a higher flue temperature not only for the actual amount of air necessary for combustion, but for all such excess air. Calculations as to boiler performance are simplified with oil fuel, as practically complete combustion is secured in a well designed furnace, the carbon and carbon monoxid usually being burned to CO_2. The stack losses include the sensible heat contained in the dry gases of combustion, the sensible and latent heat in the steam from the combustion of hydrogen and

oxygen and in the steam introduced through the burner, and the moisture present in air for combustion.

15 Assuming complete combustion, and employing a boiler radiation loss of 3 per cent, the writer has calculated the boiler efficiency, at rating, for various percentages of excess air supply, as given in Table 2.

TABLE 2 BOILER EFFICIENCY FOR EXCESS AIR SUPPLY

Excess air supply, per cent	10	50	75	100	150	200
Assumed temperature escaping gases, deg. fahr	400	450	475	490	Over 500	Over 500
Corresponding ideal efficiency of boiler per cent	84.2	80.27	77.66	75.22	Under 70.94	Under 67.09
Possible saving in fuel due to reduction of air supply to 10 per cent excess, expressed as per cent of oil actually burned under assumed conditions	0	4.67	7.78	10.68	Over 15.76	Over 20.32

The 3 per cent used for boiler radiation is subject to some variation, being greater in small boilers and less in large units. For medium units, 3 per cent is probably very close.

16 The stack temperatures for any particular type of boiler, for any given load and corresponding to any assumed per cent of excess air, will vary with the size of boiler, arrangement of heating surface, character of baffling, condition of heating surface, etc. Stack temperatures will also vary with the different types of boilers corresponding to these factors. The temperatures given corresponding to the stated air supply, from 10 to 100 per cent excess, are those to be expected in ordinary practice and necessarily approximate: with boilers having three passes of gases and sinuous headers, the temperatures in general will be lower than those indicated; with boilers having but one pass and flow of gases parallel to tubes, the temperatures in general will be higher than indicated.

17 Very few data are available for the temperatures corresponding to 150 and 200 per cent excess air, and the corresponding figures are given merely to show in a general way the magnitude of the losses easily resulting from careless firing of crude oil. The flue temperatures assumed are also subject to variation dependent on the rate of forcing the boiler and other well known elementary factors. The excess air with careless oil burning is usually greater than with careless coal firing, because of the greater excess draft power of chimneys.

In the preceding table the writer has calculated the saving that could be effected by reducing the air supply from that specified to an ideal condition assumed to correspond to 10 per cent excess air. This saving in fuel is of vast importance, but has been almost completely neglected with oil fuel.

18 It is possible to obtain a fair notion of the percentage of excess air from a mere determination of the amount of CO_2,—that is, assuming all hydrogen having been burned to H_2O and all carbon to CO_2. Any simple formula involving the element CO_2 must be dependent on an assumed percentage of hydrogen in the oil fuel, but inasmuch as the hydrogen contained is fairly uniform for any given grade of oil, there is but little error in such an assumption.

TABLE 3 POUNDS OF AIR PER POUND OF OIL AND RATIO OF AIR SUPPLIED TO THAT CHEMICALLY REQUIRED

Per cent CO_2 by volume as shown by analysis dry chimney gases	Light oil C, 84 per cent; H, 13; S, 0.8; N, 0.2; O, 1; H_2O, 1		Medium oil C, 85 per cent; H, 12; S, 0.8; N, 0.2; O, 1; H_2O, 1		Heavy oil C, 86 per cent; H, 11; S, 0.8; N, 0.2; O, 1; H_2O, 1	
	Pounds of air per pound oil	Ratio air supply to chemical requirements	Pounds of air per pound oil	Ratio air supply to chemical requirements	Pounds of air per pound oil	Ratio air supply to chemical requirements
4	51.40	3.607	51.93	3.704	52.45	3.803
5	41.31	2.899	41.71	2.975	42.12	3.054
6	34.58	2.427	34.90	2.490	35.23	2.554
7	29.77	2.089	30.04	2.143	30.31	2.198
8	26.17	1.836	26.39	1.883	26.62	1.930
9	23.37	1.640	23.56	1.680	23.75	1.722
10	21.12	1.482	21.29	1.518	21.45	1.555
11	19.83	1.391	19.43	1.386	19.58	1.419
12	17.76	1.246	17.88	1.276	18.01	1.306
13	16.46	1.155	16.57	1.182	16.69	1.210
14	15.36	1.078	15.45	1.102	15.55	1.127
15	14.39	1.010	14.48	1.033	14.57	1.056

19 Table 3 shows the calculated weight of air per pound of oil and the ratio of actual air supply to chemical requirements, for the various grades of oil and various percentages of CO_2. Under the present systems of firing the amount of CO_2 present in the flue gases is often as low as 4 or 5 per cent. With an ample supply of labor and a careful and scientific adjustment of dampers by hand, the percentage of CO_2 under an ideal and uniform load can be maintained as high as 13 per cent. With automatic control and under variable load conditions it has been found possible to maintain a high percentage of CO_2 conforming very closely to ideal conditions.

20 The first notable step in advance of the crude systems of hand firing was at the plant of the Pacific Electric Railway Company, Los Angeles, Cal., under the direction of Mr. J. R. Atchison, then Chief Engineer for that company, now Superintendent of Construction for Chas. C. Moore and Company, Engineers. Mr. Atchison developed a plan for firing 18 boilers, averaging 3 burners per boiler, totaling about 54 burners, with central hand control of oil pressure.

21 The operator was stationed near the oil pumps, which were run at a practically constant speed. In front of the operator were the oil pressure gauge connecting to oil main and the steam pressure gauge connecting to steam main. The operator's duty was to maintain a uniform steam pressure on the boilers by opening or closing a bleeder valve on the oil pump discharge line, thus increasing or decreasing the pressure in the oil main, and simultaneously the rate of firing of all of the boilers. The operating crew of the boiler room for each shift consisted of the one operator controlling the oil pressure and one water tender; which is probably the record to date for the minimum of boiler room labor for any plant of this size. It was a simple matter to substitute automatic regulation for hand control, following which the writer conceived the idea of utilizing this variation in oil pressure as a secondary means for controlling the supply of steam to burners and the air supply for combustion.

22 The writer will now explain the principle of operation, details of construction and results in actual trial of the Moore-Patent automatic fuel oil regulating system. This system controls the supply of oil to all burners, the supply of the atomizing agent to all burners, and the supply of air for combustion, for any number of boilers, all from a central point. The results are: increased boiler plant efficiency, the practical prevention of smoke, and decrease in the maintenance cost of boiler equipment, due to a more uniform manner of firing.

23 In this system all individual burner valves, both steam and oil, are opened wide or nearly so, and all burners are operated under full pressure in the respective mains. In the larger plants all dampers are connected to a common rock shaft and move simultaneously.

24 A slight variation in the steam pressure on the boilers, due to any variation in the demand for steam, is the primary means of control for a steam regulator or governor which varies the oil pressure at the oil pumps and in the oil main. Corresponding to an increased pressure in the oil main, there is an increase in the amount of oil fired and a rise in boiler steam pressure; and corresponding to a decrease of pressure in the oil main, there is a decrease in the rate of oil fired

and a lowering of the boiler steam pressure; this regulator thus maintains a uniform steam pressure on boilers at all loads within the governing limits. The variation in pressure in the oil main is the secondary means for controlling the supply of steam for atomizing purposes and also for controlling the supply of air for combustion.

25 The supply of steam to burners is controlled by regulating the pressure in a separate low-pressure main common to all burners, the pressure in this main bearing a certain predetermined relationship to the pressure in the oil main and being controlled by a ratio regulator. By means of a specially constructed diaphragm regulator, the opening of the boiler dampers is made to increase or decrease with a corresponding variation of pressure in the oil main, the change in damper opening, in turn, governing the supply of air for combustion.

MAINTENANCE OF A UNIFORM STEAM PRESSURE BY REGULATING THE OIL PRESSURE

26 Any reliable pump governor can be used to control the oil pressure in the oil main so as to maintain a uniform steam pressure. This governor can be used to operate either a throttle in the steam supply to the steam-operated oil pump, or a bleeder valve in the oil pump discharge pipe. The writer's experience has been most satisfactory in the use of the well known Spencer damper regulator, the movement of the power lever being used to control the bleeder valve in the oil pipe discharge, in lieu of connecting it to the damper, as is done in damper regulation service for coal burning plants.

27 Difficulty will be experienced in any endeavor to maintain a uniform steam pressure by regulating the oil pressure if it is attempted to effect this by controlling the supply of steam to the throttle of the oil pump. This is because of the surging of the oil pressure due to the alternate speeding up and slowing down of the pump; a difficulty that can be overcome in a measure by very careful adjustment, though the writer does not deem the attempt worth while. In such an attempt difficulties will also be encountered, due to the storage of heat in the boiler and boiler setting, and the time interval, corresponding to a change in the rate of firing the boiler, necessary to restore the steam pressure to the normal. The same difficulty will exist in a measure with regulation of the oil pressure by a bleeder valve on the oil discharge, provided it is attempted to connect the regulator so as to control the boiler plant automatically through the entire range of load.

28 By reason of the influence on the economy of plant of the rate of variation in oil pressure, and consequently in the intensity of fires, it is important that the ideal conditions be approached as nearly as may be; and to this end it has been found more economical to maintain, as nearly as possible, a uniform rate of firing with gradual changes in rate of firing due to changes in load on the boiler plant. When this system was first tried out at the Redondo Plant of the Pacific Light and Power Company, where the tests forming the basis of another paper presented by the writer at this meeting were made, the steam pressure regulator was used to control the entire plant of eighteen 600-h.p. boilers, although the steam-to-burner regulator and damper controller were connected only to the six boilers included in the No. 2 plant unit.

29 Before the installation of the automatic steam pressure regulator, central hand regulation was employed. Fig. 1 shows the record from a Bristol recording gauge connected to the oil pressure main, and the corresponding record of the steam pressure, with hand regulation.

30 In adjusting the regulator for maintaining a constant steam pressure it was at first attempted to control the oil pressure for the entire range of load, and results somewhat similar to those indicated above for hand regulation were secured. It was finally found desirable to limit the regulation to such amount of opening or closing of the bleeder valve as would vary the oil pressure through a range of from one-fourth to one-third of the total variation required. When so operated the supply of steam to the oil pressure pump was direct from the auxiliary steam main and the throttle was hand-adjusted from time to time, whenever the range in load exceeded the limits of the steam regulator. Thus connected, the steam governor became an aid to the fireman, though not completely automatic in its action. When approaching either the upper or lower limit of the regulator, the condition is easily apparent from the position of the regulator yard arm, and the fireman in charge then slightly increases or decreases the rate of oil pumping, dependent on plant requirements. No additional labor is necessary on account of such connection, and except when passing over peak loads, it is unnecessary to adjust the oil pump throttle more frequently than every two or three hours. The corresponding oil and steam pressure records from such regulation are reproduced in Fig. 2, in which the curves are smoother than with hand adjustment for the oil pressure as well as the boiler steam pressure. These curves were obtained in a violently fluctuating

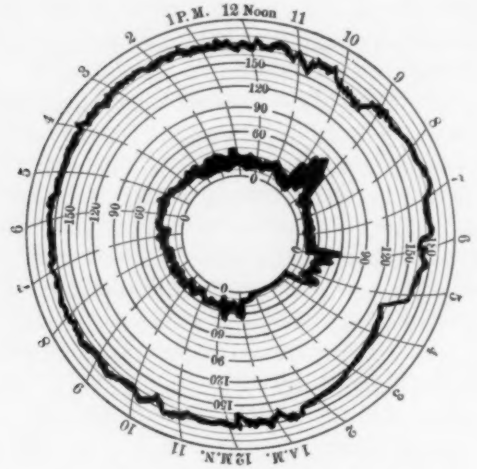

Fig. 1 Record Showing Pressures in Main Steam Pipe and Oil-pressure Main, Corresponding to Hand Regulation of Oil Pressure. Inner Curve Oil Pressure, Outer Curve Steam Pressure.

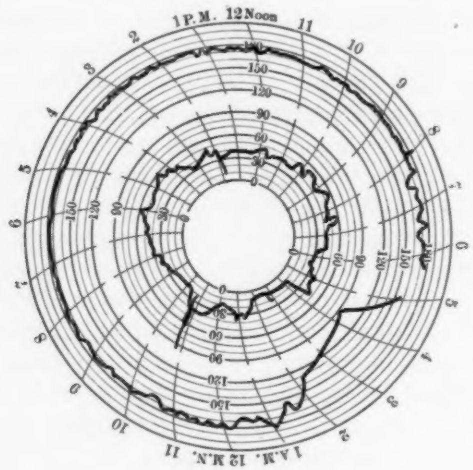

Fig. 2 Record Showing Pressures in Main Steam Pipe and Oil-Pressure Main, Corresponding to Automatic Control. Inner Curve Oil Pressure, Outer Curve Steam Pressure.

railway load, where the momentary swing in load would vary at times from 20 to 100 per cent of the unit capacity.

31 The increased economy due to such uniform rate of firing is self-evident, as well as the saving in the attention required for the adjustment of the steam supply to burners and of the air supply for combustion. In actual experience this system of regulation has been found absolutely reliable and the firemen have been found not only very much interested in it, but exceedingly anxious for its installation, owing to the saving in labor and the superior steam and oil regulation produced.

STEAM-TO-BURNER REGULATOR

32 Before the development of this regulator, tests were made to determine the relationship between the amount of steam required for atomizing oil and the amount of oil burned. Pressure gauges were connected on the branch pipes for both oil and steam, between the respective throttle valves and the burner head. The burner was fired at various measured rates and record made of the steam and oil pressures. It was found that for a variety of burners this relationship could be represented by a straight line, the required steam pressure being equivalent to the product of the oil pressure by a constant, plus a fixed pressure difference. With the outside mixing burner used at Redondo, this relationship was about as follows: Steam pressure $= 3 \times$ oil pressure $+ 20$. The constants for ratio and difference will vary with the type of burner and the relative sizes of burner orifices for steam and oil, as well as with the viscosity and temperature of the oil.

33 With this fact established, it became a simple matter to design a regulator, of which the essentials were opposing steam and oil diaphragms with areas or leverages conforming to the observed ratio, and a weight element equivalent to the required difference in pressures. Accordingly a s'mple regulator was designed, the final development of which is as shown in Fig. 3. In this regulator the upward pressure is exerted on two diaphragms, the one at the left subject to the oil pressure in the oil main, the one at the right to the steam pressure in the low pressure steam main connected to the burners.

34 The fulcrum is adjustable for any desired ratio of leverages. The yard arm is counterbalanced at the left, and weighted at the right for the desired weight constant due to the pressure difference factor. Whenever equilibrium is disturbed by variation in oil pressure, the

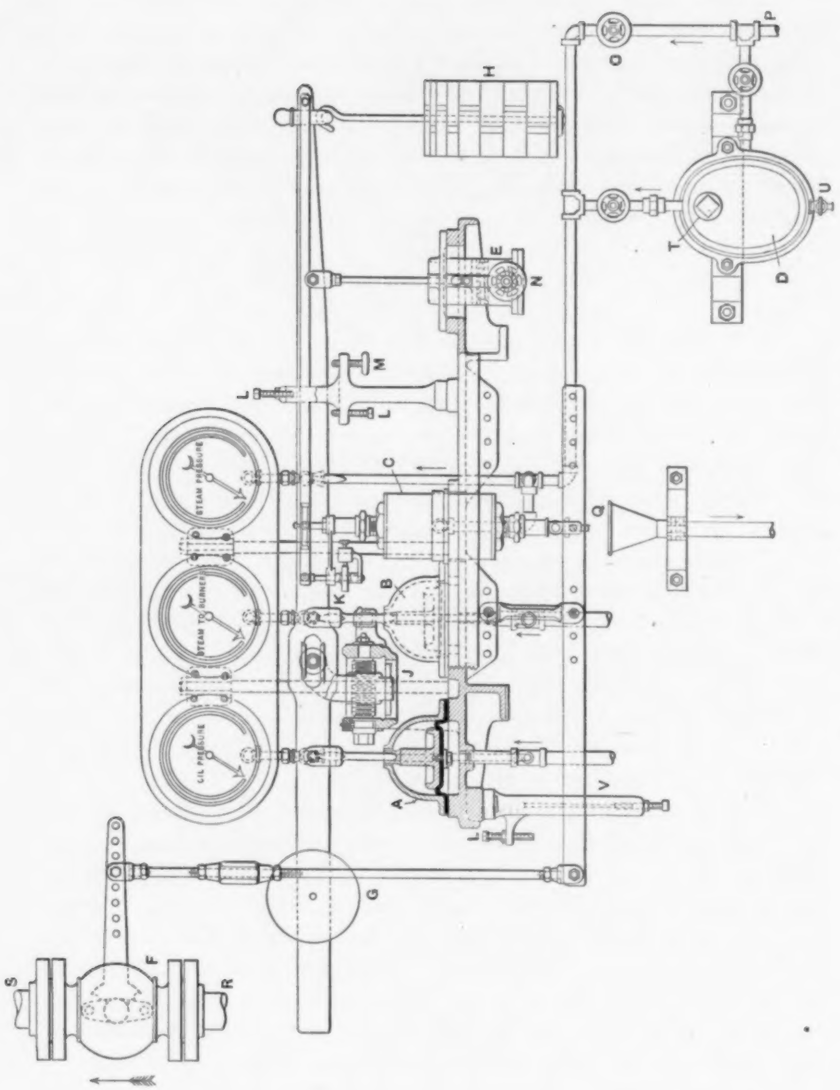

FIG. 3 STEAM-TO-BURNER REGULATOR

main yard arm will be compelled to move either up or down. This motion is communicated to a water cylinder or motor, such as used on the well known Spencer damper regulator. The movement of the water cylinder in turn operates a suitable lever and connecting rod and finally a rotary chronometer valve, which increases or decreases the supply of steam to the low pressure steam main in such a manner as to restore equilibrium, thereby providing the desired increase or decrease corresponding to the initial change in oil pressure. The pressure guages shown indicate at a glance the pressure on the oil main, the pressure on steam-to-burner main and the water supply pressure actuating the water cylinder. The following is a list of the lettered parts in Fig. 3.

A Diaphragm Actuated by Pressure in Oil-to-Burner Main
B Diaphragm Actuated by Pressure in Steam-to-Burner Main
C Water Motor
D Water Strainer
E Dash-Pot
F Conical Seated Chronometer Valve
G Sliding Counter Balance
H Adjustable Weights
J Fulcrum Adjustment
O By-Pass Valve around Water Strainer
P Water Pressure Inlet
R High Pressure Steam from Boilers
S Low Pressure Steam to Steam-to-Burner Main
V Guide for Lever with Stop Screws

35 The writer would refer those not familiar with the operation of the Spencer water cylinder to a descriptive catalogue of the Spencer damper controller. This regulator has been entirely successful in actual experience, and is completely automatic in action; although on swinging loads a further saving in steam supply to burners can be effected by a slight adjustment of the amount of weight on the weight arm. This adjustment will cause a slight constant increase or decrease in the steam-to-burner pressure main, as observation of fires dictates.

36 When boiler fires are started, it is usually a fact that the oil in the main is a little colder than under normal conditions corresponding to which a greater oil pressure is required; this increased oil pressure in turn provides the necessary increased steam pressure and supply of steam for the atomization of the colder oil. There is a further furnace effect, as not only is an increased amount of air for combustion required when furnaces are cold, but also a greater

amount of steam for atomization. Correspondingly, after boilers have been fired for a number of hours, or on cutting down the load after having passed over a peak, the furnace walls will be found somewhat hotter than the normal, corresponding to which a slight reduction in the amount of steam for atomization is permissible, as well as in the air supply for combustion. A slight adjustment of the weights at such critical periods of the load will give a slightly increased economy.

37 If the grade of oil varies from day to day, and if the temperature of oil in the oil main is not maintained uniform, this condition can also be corrected by weight adjustment. It is essential that the oil main be of a size that will make the pressure substantially uniform throughout the entire plant, otherwise there will be a variation in the amount of oil fired by the individual burners. It is also essential that the low pressure steam main be of such size that the steam pressure will likewise be uniform throughout the plant.

38 In addition to the economy effected by this system due to a saving in steam-to-burners, there is a secondary economy in the more efficient combustion of oil due to proper atomization at all times.

DAMPER CONTROLLER

39 In the development of the damper controller, tests were made to determine the relationship between variations in the amount of damper opening and variations in the pressure of oil on the burner orifice. It was found that this relationship could be represented approximately by a straight line, although the total amount of damper opening was not found to be directly proportional to the total oil pressure.

40 In the development of this regulator the writer regarded perfect regulation as an impossibility, and any degree of regulation giving even approximately the proper amount of air for variations in loads, as an important step in the economical operation of oil burning plants. Accordingly a trial regulator was constructed, having a diaphragm actuated by the pressure of oil in the oil main, the movement of the diaphragm being opposed by a lever connected to a coil spring. In this regulator the amount of movement of the diaphragm and of the lever was proportional to the oil pressure after passing the point of zero spring tension. This amount of motion of the main lever was multiplied and transmitted to a rock shaft operating the six boiler dampers in No. 2 unit, by means of a water

controlling valve and a suitable hydraulic cylinder connected to a rock shaft.

41 As a result of the experiment it was found that by a cut and try process, with levers and rods at various angles, a movement of dampers could be secured through the working range of load, giving an air supply at all loads but slightly in excess of theoretical requirements.

42 The final development of this regulator for large plants is shown in Fig. 4. In this regulator the large diaphragm is subject to the upward pressure corresponding to that in the oil main. The motion of the lever is opposed by a coil spring adjustable in position along the lever so as to obtain the required range of motion of the dampers corresponding to the given range of oil pressure. By means of a double-ported controlling valve, connected to the damper controller, the supply of water under pressure is admitted either to the top or the bottom of the hydraulic cylinder connected to the rock shaft. The control is on the principle of the well known differential lever, such as is used in a steering gear, and also common to many types of damper regulators.

43 After being once properly adjusted for its entire range of motion, this regulator gives entire satisfaction. It is subject to variation from certain external influences, such as the temperature of the boiler furnace on approaching or receding from peak loads or in starting fires, and variations in the temperature and density of oil. Immediate adjustment and correction for these difficulties can be made by a slight turning of the hand wheel on the coil spring, giving a constant change in the amount of opening or closing of all dampers. In actual experience, no adjustment of the damper controller has been necessary except at intervals of three or four hours, depending on the nature of the load carried, the frequency of peaks, etc.

GENERAL ARRANGEMENT OF REGULATORS AND PIPING

44 Fig. 5 and 6 show the arrangement of boiler plant and the main piping connections for the steam-to-burner regulator and damper controller. The writer has deemed it unnecessary to illustrate the oil pump governor for maintaining a uniform steam pressure as it involves nothing of novelty in its construction.

45 In order to prevent the corrosive action of the oil fuel on the rubber diaphragms it has been found necessary to interpose a water cylinder in the oil pressure line, as shown in the illustration. A pipe

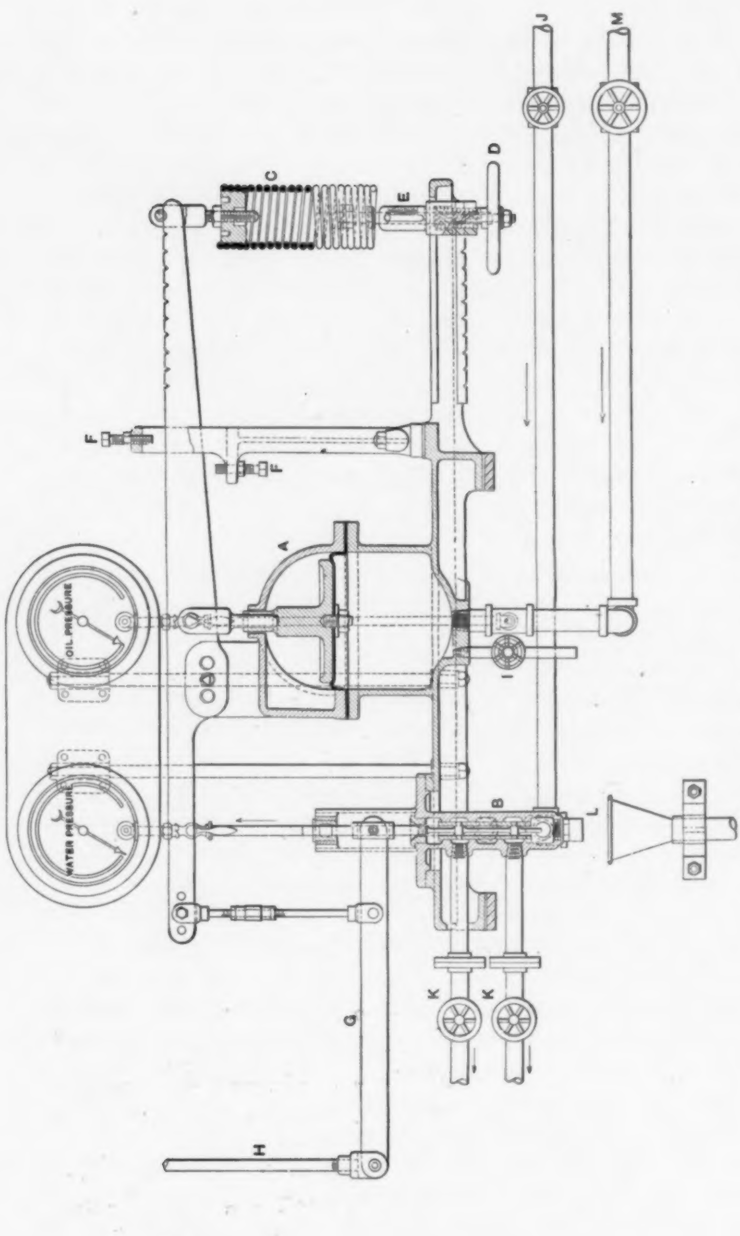

FIG. 4 DAMPER CONTROLLER

A DIAPHRAGM ACTUATED BY PRESSURE IN OIL-TO-BURNER MAIN
B WATER CONTROL VALVE OPERATING HYDRAULIC RAM
C ADJUSTABLE COIL SPRING
G DIFFERENTIAL LEVER
H CONNECTING ROD FROM ROCK SHAFT TO DIFFERENTIAL LEVER
J WATER PRESSURE INLET TO CONTROL VALVE
K SUPPLY AND RETURNING LINES TO HYDRAULIC CYLINDER
M PIPE CONNECTION TO INTERMEDIATE WATER RESERVOIR

from the oil pressure main is connected to the top of this cylinder. Water connection is provided from the bottom of the cylinder to the steam-to-burner regulator and to the damper controller, thus protecting the diaphragms from oil. This water cylinder is connected with the city water main for convenience in filling due to leakage, etc. The chronometer valve on the steam-to-burner regulator must be carefully proportioned for the maximum requirements of the plant, and the relative amount of opening due to the regulator so adjusted. A pipe stanchion should connect the steam pipe to the floor to prevent change in its position relative to the chronometer valve. The chronometer valve should be by-passed so that the supply of steam to the burners can be regulated by the hand throttle valve shown, when it is necessary to cut out the regulator and to clean the pilot valve of the Spencer water cylinder; the frequency of this operation is dependent on the hardness of the water supplied under pressure for operating the damper.

46 The installation of the damper controller is simple, but it is important to place the controlling lever connecting from the rock shaft to the differential lever at such an angle as to give the right amount of damper opening under all conditions of load.

47 The piping to the hydraulic cylinder should be so valved that when it is necessary to cut the damper controller out of service for replacement of the diaphragm, etc., the movement of the hydraulic cylinder can be effected by hand control of the valves in the pipes supplying the pressure water to the opposite ends of the hydraulic cylinder.

48 The rock shaft should be counterweighted, so that in case of accident the counterweights will open all dampers. The connection from the individual dampers to the rock shaft is by means of a chain, the dampers also being supplied with individual counterweights and so arranged that individual dampers can be adjusted by hand when conditions require it. It is desirable to limit the minimum and maximum opening of the dampers by means of suitable collars on the plunger rod of the hydraulic cylinder. The minimum opening is determined by the extent to which the dampers can be closed without producing explosions of the gases which collect in the furnaces and gas passages, and the maximum is determined by the plant requirements.

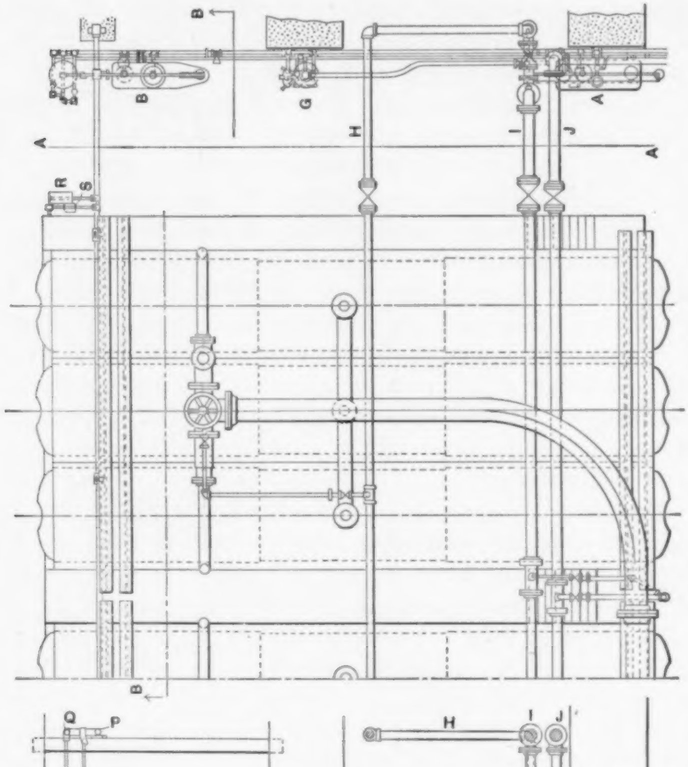

FIG. 5 GENERAL ARRANGEMENT OF APPARATUS—SECTIONAL ELEVATION AND PLAN

LIST OF PARTS, FIG. 5 AND 6

- A Steam-to-Burner Regulator
- B Damper Controller
- C Hydraulic Ram Actuated by Damper Controller
- D Chronometer Valve Actuated by Steam-to-Burner Regulator.
- G Water Chamber, Subject to Oil Pressure, to Protect Rubber Diaphragms
- H High Pressure Steam From Boilers
- I Low Pressure Steam to Steam-to-Burner Main
- J Oil-to-Burner Main
- K City Water Pressure Main
- L Oil Strainers
- P Damper Rock-Shaft, Operated by Ram
- R Balance Weight
- V Connecting Rod, Rock-Shaft to Differential Lever

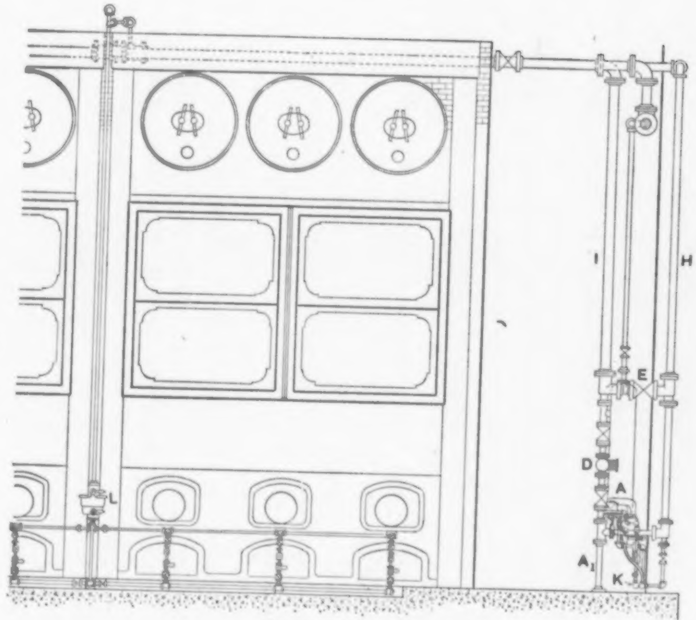

Fig. 6 General Arrangement of Apparatus—Front Elevation and List of Parts

OPERATION OF THE COMPLETE SYSTEM

49 It is unnecessary to disconnect any of the regulators during the starting or stopping of the plant, as these will perform their respective functions automatically.

50 In case of accident, the steam pressure governor can be cut out by merely closing a valve between the oil main and the bleeder valve; when the oil pressure can be varied by hand control of the pump throttle. To cut out the steam-to-burner regulator, it is necessary merely to open the by-pass valve and close the other two valves (shown in Fig. 3). To cut out the damper controller, it is necessary only to close a valve in the supply pipe to the water controlling valve and to open to waste the valves connecting with the water cylinders, when the counterweights will immediately throw all the dampers wide open and permit individual hand control. The hydraulic cylinder can be used to control all the dampers as explained above by controlling by hand the supply of water under pressure to the cylinder. Any regulator can be eliminated without interfering with the functions of the remaining regulators, and any boiler may be cut out of service without affecting the regulators.

51 After the fires are started as usual and the boilers are fairly well under load, it is customary to equalize all the fires and to make a refined setting of both steam-to-burner regulator and damper controller. The respective dampers having once been properly set, all the fires may be equalized by a slight closing or opening of all the oil burner valves, so gauging the supply of oil as to produce the desired excess of air, which condition will be known to exist when the right degree of smoky haze appears in the gases well beyond the combustion zone, as viewed through peep holes provided for the purpose. The next operation is to equalize the supply of steam-to-burners by slightly opening or closing all steam supply valves on the burners. If a greater damper opening is required for the given load, adjustment of the spring tension will give the desired results. If a change in the total supply of steam-to-burners is necessary, a weight adjustment at the regulator will suffice. Thereafter with the same character of fuel oil, and with care in the maintenance of a fairly constant temperature of oil, no further adjustment of regulators or burners will be necessary until a peak load has been passed, when a further slight adjustment should be made for reasons explained above. This individual adjustment of burners is necessary owing to the fact that the burner orifices become unequally worn and fouled by use.

52 While this system results in an appreciable saving in manual labor, it does not dispense with any considerable number of firemen. The firemen should observe the working of fires continually to make certain that exterior causes are not preventing the regulators from performing their respective functions, and it is only by careful and continual observation that the firemen are enabled to maintain the highest economy, by correcting the external conditions which the regulators are incapable of anticipating, with the refined adjustments mentioned above.

53 Contrary to the usual attitude of power plant operatives toward automatic contrivances, it is a fact that all firemen who have had experience with these regulators so far willingly observe instructions regarding their use and coöperate to secure favorable results. It is only natural that firemen should regard this system with favor, inasmuch as the manual labor of attending to boilers is greatly lessened. The time made available should be spent, however, in giving more attention to the refined adjustments important to securing the highest economy.

54 On momentary changes of load of considerable magnitude, sufficient to cause appreciable change in the boiler steam pressure, all the regulators will act promptly and synchronously. The writer has observed this apparatus during periods of short circuits on a station, followed by an interval during which no power was developed. All the regulators performed their functions admirably during this change, from maximum to minimum position, and during the succeeding opening up of dampers and building up of fires to normal conditions.

55 After a certain set of conditions become established for a given load, including the rate of flow of chimney gases, temperature of gases, the draft, etc., the regulator will respond more readily than the chimney to momentary changes. Owing to the fact that the damper controller is set for the continuous operating conditions at each load, it frequently happens that the chimney does not respond with sufficient rapidity, causing momentary smoking. If the load remains unchanged for a short period then normal conditions will gradually establish themselves, and smoking cease, except for a slight haze required for economical oil firing.

56 It is not usual that reliability of operation results from the use of automatic contrivances and the trend of engineering is adverse to their use. In actual practice it has been shown, however, that these regulators are completely dependable, a case of failure in actual

service not having resulted since the completion of this system at the Redondo Plant. It will be noted that the regulators are massive in design and simplified to the extreme. There are certain parts of this system which require care, and when such care is bestowed there is little liability of any interruption in service.

57 Records in coal burning plants showing failure during operation of the better types of ordinary damper regulators, are certainly few. There is possibly no single automatic apparatus more complicated than a modern engine shaft governor with its valve gearing, particularly on a large engine, but its success is due to its massive design and its power to do work in comparison with the opposing forces; and it is universally accepted without question as to its reliability. This system requires a continuous supply of water under pressure which is ordinarily obtained from the city mains. The writer recommends a reserve supply tank on the power plant roof, and also a connection, to be used when required, from the boiler feed main.

58 The writer regrets his inability to present a statement showing the saving in fuel effected by this system, as compared with hand operation. In tests made at the Redondo Plant, a saving is apparent, but the figures are so involved as not to be in a convenient shape for presentation. As compared with the other units of this plant which were not so regulated, the evidence of lower temperature of flue gases, and more even regulation of the degree of superheat, are significant. The saving to be expected from the use of this system, would naturally be greatest in plants where the load is most widely variable; as with such a load, it is impossible, with hand adjustment of dampers, to work sufficiently close to the economical requirements of air supply.

59 In small stations, the pressure governor and steam-to-burner regulator would be of a design similar to that illustrated. The damper controller, however, would be simplified by the omission of the separate hydraulic cylinder, there being used an apparatus similar to the Spencer damper regulator, a tension spring being substituted for the weight on the yard arm, commonly used in coal burning practice.

60 The writer would urge central regulation of oil pressure regardless of the size of the plant. It would be possible in large stations to have central control of the steam supply to burners, and of the dampers. It will usually prove more convenient however, by reason of possible variation in the oil pressure in different parts of the plant, to use separate steam-to-burner regulators and separate

damper controllers, on each unit or panel, up to the limit of about 4 000 or 5 000 h.p.

This system is covered by letters patent.

CONCLUSION

61 The necessity and importance of careful regulation of air supply, in connection with coal burning plants, has of late received such widespread attention, as to make self evident the importance of some system of regulation in connection with oil burning stations. Such a system as herein described is a distinct advance in the science of burning crude oil, and is worthy of the careful investigation of those interested in the economical production of power in plants using crude oil. It is believed that a modification of this system would yield readily to the requirements of boiler plants using natural gas as fuel.

REMINISCENCES OF A GAS ENGINE DESIGNER

By L. H. Nash, New York

Member of the Society

In these short remarks I do not intend to attempt to follow the line of development of gas engines as a whole and especially not those branches of it which have been developed by many eminent engineers, because these matters have been carefully described in publications and by lectures, so that they are familiar to all gas engine engineers. My purpose is rather to present from the point of view of one of the workers the principles in which I have personally interested myself, and to trace some of these lines as they have become parts of the general art of gas engine construction.

2 In the early days, the gas engine was considered a device more adapted for small powers and was not classed as a serious rival of the steam engine. Its construction followed the lines of the old horizontal engine, of which the Otto is the best example, and the only deviation from this horizontal principle that I know of was the vertical Otto engine, in which the crank was above the cylinder, and in which all accumulations of oil remained in the bottom of the cylinder. I had a friend who used to spend every Saturday night cleaning up his engine in order that it might be ready for the following week's operation.

3 It seemed to me, therefore, absolutely essential that the cylinder be placed above the crank shaft so that all waste products could escape from the fire chamber so far as possible. That principle has now been adopted by all makers of vertical engines. Such a construction now seems obvious, and when one realizes that steam engines of this form were in common use, it seems a little surprising that the advantages of the vertical engine were so slowly recognized.

4 The working fluid of an internal combustion engine is gas at extremely high temperatures, and in that it differs from the steam

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engine. It has taken many years of careful thought to provide a structure in which these gases can be handled without danger of destroying the mechanism or of injuring its bearing surfaces; and while today all these difficulties are overcome, the need was by no means obvious to the early designers of engines, and even now, when a new man begins the construction of an engine of this class, his greatest liability to mistake lies right in this lack of appreciation of the necessity of using cooling water at every point where heat can possibly cause injury to the parts.

5 Naturally, in the development of a new device having such peculiar characteristics and hoped-for possibilities of economy, a great variety of expedients and of mechanism have been adopted. The process of evolution gradually eliminates many of these, and others find their uses in peculiar conditions and become standard for special work. It was natural to follow, to a large extent, the lines of the steam engine and this seems to have been the first step in the art, especially in Great Britain.

6 The great amount of heat ejected from a gas engine naturally led people to think of combining a gas and steam engine to utilize this waste heat. The writer once thought he had evolved a brand new idea in this line and made application for a patent upon it. The application was acted upon by the United States Patent Office and every one of the broadest claims were allowed. He had thought of riches beyond the "dream of avarice;" but in a fatal hour the examiner discovered some British patents, and not only a few, but many of them, in which it seemed as if the ingenuity of inventors had been exhausted in combining gas engines and steam engines, at least on paper. Needless to say, the dream of immense wealth passed away. But while this idea of combined steam and gas engines seemed so attractive to many, I do not know that it has ever been embodied in a commercial structure. The difficulties of carrying the thing to a conclusion seemed too great to warrant the outlay, and while to a certain extent the waste heat of the gas engine is utilized for commercial purposes, in other ways the development in this line has not been very extensive. The amount of heat that can be saved is very large, and as larger installations of gas engine power plants are used, and the cost of fuel becomes a more important factor, the cost of installing these heat saving appliances will no longer be considered prohibitive, but with small units very little has been done.

7 The use of gas engines for marine propulsion was one of my earliest dreams and the problem still seems only partially solved.

Notwithstanding the large number of engines used in motor boats and the fact that some vessels are being equipped with gas engines, it is fair to say that the problem is to-day in its infancy.

8 Fig. 1 shows an attempt along these lines made by me 25 years ago, and not yet realized except in part. This cycle of operations, so far as I know, has never been adopted in any gas engine, and it seems to have some merit for the purpose of marine propulsion.

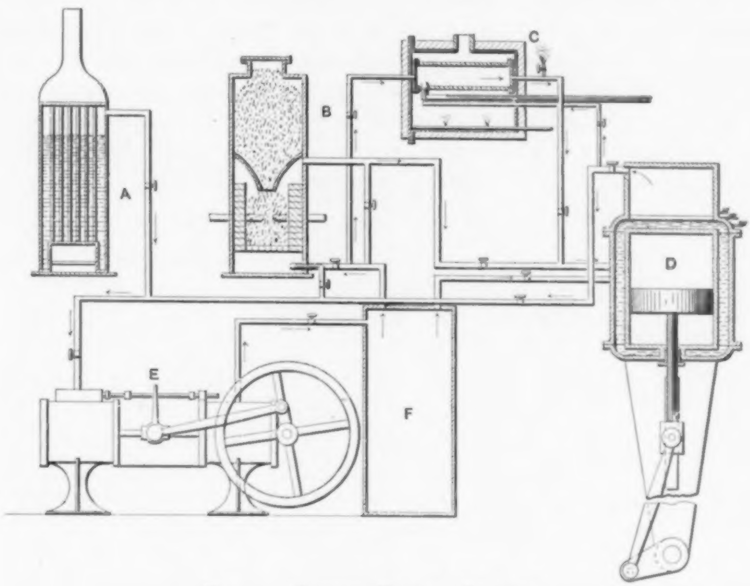

FIG. 1 MARINE ENGINE SYSTEM

A, Steam Boiler; *B*, Coal Gas Producer; *C*, Liquid Fuel Gas Generator; *D*, Engine; E, Compressor; *F*, Air Storage Tank.

9 Referring to the figures, it will be seen that it was proposed to supply the engine with fuel, either coal or a liquid. The steam boiler was to be retained for emergency work; an independent air compressor was to furnish the means of supplying the compressed charge as required, and the engine was to operate with a cycle in which the regulation could be controlled at will without danger of shutting down from failure of its own mechanism; in other words, the starting was to be effected by external means, consisting of compressed air furnished from a reservoir or a compressor actively operated by a separate source of power. As a different application of a part of this idea, I designed a compressor driven by a gas engine cylinder instead

of steam. The engine was to be double-acting and all wearing parts were to be provided with an elaborate system of water cooling for piston rods, pistons, etc. I believe this system has never been completely adopted as a whole, although many of its features are to-day parts of standard engines. The method of starting by compressed air is now used in all large gas engine units; but the peculiar cycle of operations I think has never been put into practice.

10 Notice in Fig. 2 the proposal to introduce the charge into the cylinder under pressure and then to cut it off and ignite it at some point during the forward stroke of the piston. The governing would be by cut-off, by the methods usual in steam engines. The very wide range of power cards which could be obtained from a given cylinder is suggested. The engine was to be reversible like a steam engine, by the use of the usual link and eccentrics.

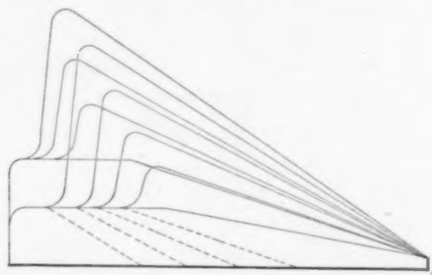

Fig. 2 Diagram Indicating Form of Cards of Marine Engine Admitting Charge under Variable Cut-off and Pressure

11 The method herein indicated of supplying the engine with charge under pressure, seems to have some merit; in fact, I look back on this old idea with considerable curiosity that some one has not used it. I still believe that the method of operation described in this old patent will give the best solution yet offered of the marine gas engine. The method of generating the gas in a generator under pressure does not seem to have been tried and may still prove of value, but taking the system as a whole, the possibility of constant operation of the engine, and its ability to reverse or start under any circumstances should make it as valuable as a steam plant, and if the apparatus for furnishing the charge is made in multiple, as is the boiler supply for a steam engine, this idea should be no less reliable in service than standard marine engines using steam.

12 The cost of developing engines of a large size, and especially for marine work, was far beyond the financial resources back of the writer,

who was obliged to devote himself to smaller problems. The patent has expired, and the idea is left to take its place in the general evolution of the gas engine art and perhaps to suggest what might have been or may yet be. But many of its features will be found in existing engines, and if the original claims were still in force many an engine builder would be required to pay royalties to-day.

13 Economy in the use of fuel is to be secured by high initial pressure, but the use of high pressures in a cylinder requires more perfect workmanship to prevent loss by leakage of the charge, so that what may be gained in a structure theoretically may readily be lost by any defect in the mechanism.

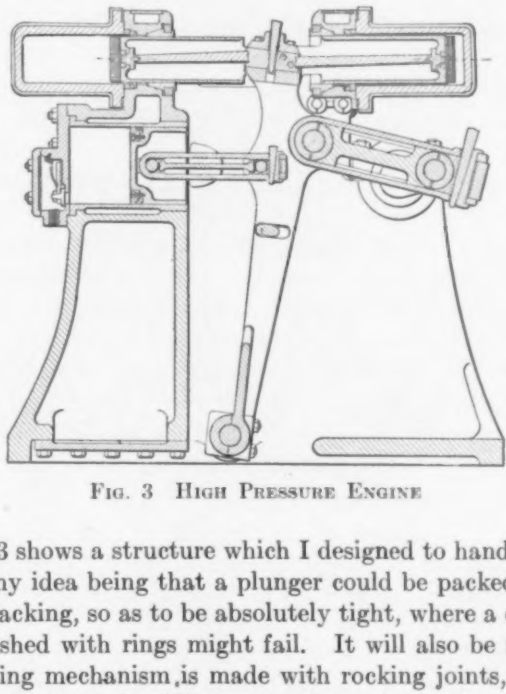

Fig. 3 High Pressure Engine

14 Fig. 3 shows a structure which I designed to handle very high pressures; my idea being that a plunger could be packed by the use of flexible packing, so as to be absolutely tight, where a cylinder and piston furnished with rings might fail. It will also be noticed that the connecting mechanism is made with rocking joints, which need no lubrication, the ends of the connecting rod and the bearing upon which they operate being cylindrical and made of hardened steel. Cards made from this structure demonstrated the fact that a very high degree of economy could be secured.

15 Two things prevented success at this time, however. In the first place the electric igniter, now in common use, was not then available, and it was necessary to use the old-fashioned flame igniter,

which introduced many complications; and I was also convinced that the use of high compression would not prove a commercial success, in small units at least. When the Diesel motor was placed upon the market in small units, therefore, I watched the development with a great deal of interest to see whether I was not correct in my judgment, and the early history of the first engines introduced amply proved that it would have been a mistake for our company to continue further in this line of work.

16 Notwithstanding the fact that the Diesel engine has overcome these difficulties and is to-day a commercial success, at least on the larger sizes, the road to the development of this idea was not easy for the investor. The enthusiastic designer in his quest for rainbows must keep his feet on the solid ground of commercial success, and yet, looking back over the state of the art, these early efforts are of interest from the point of view of the difficulties which have been overcome and the suggestions many of them still contain, which may be embodied in future work.

17 The efforts of the writer were rather confined to the production of smaller units. It was thought that a motor for running sewing machines would be a money maker, and Fig. 4 shows a small motor which he designed for this purpose. It had a flame igniter, and was cooled by an air jacket in which a draught was induced by injector action of the air escaping from the crank chamber. It was a beautiful little piece of mechanism, and in the hands of a skilled mechanic, who would keep it clean and take care of it, it seemed that nothing could be more perfect; but alas the average woman could not qualify. The necessary care could not be depended upon, and after many months of hard work I gave up the idea and started in on easier problems.

18 The problem of igniting the charge was a very serious one in the early days as electric apparatus adequate to produce reliable ignition had not yet been developed. I made several attempts at jump spark apparatus, but it was always unreliable in some respects. I had a little sparking dynamo made by a friend in the electric business, which was all right; but the method of insulating the terminals had not yet been worked out satisfactorily. Mica was used, but was liable to become water-soaked. The general impression was that the flame was the most reliable thing. Many months of work were devoted to the production of flame igniters which were probably as reliable as could be expected of them. The difficulties, of course, always lay in the fact that the flame must be carried in through a valve and the soot

and oil used in lubricating the valve soon destroyed the joint-forming surfaces.

19 The next expedient was the hot tube, which had many features of value but could not compare with the present method of igniting the charge by electric spark. I also used incandescent wire, heated by electric current.

20 Simple as the igniting apparatus of an engine is, there is nothing of more importance, and yet even to-day the problem is unsettled and many people are at work making improvements along

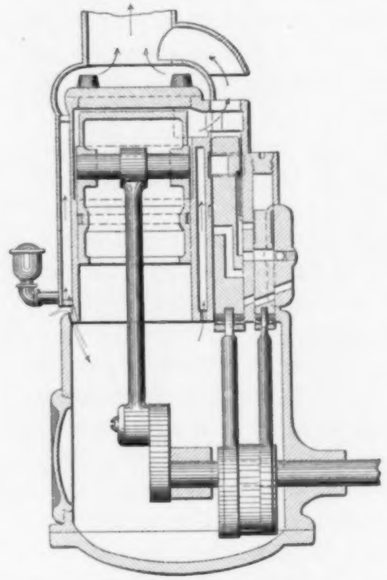

FIG. 4 SEWING MACHINE MOTOR

this line. But undoubtedly the lack of absolutely perfect ignition has been one of the features which has retarded the development of the gas engine. I still look for improvement in this line, although there are many serviceable forms of igniting apparatus which operate reliably, under reasonable care. That the gas engine engineer is dependent upon the electrician for the solution of one of the most important problems in his art shows how the arts are allied.

21 When one looks back over the march of improvement in any art, what naturally strikes the observer is the amount of work which has been expended in developing side issues or modifications of what

was finally proved the fittest device. Most of these ideas, like that of Professor Atkinson, are based on theory which warrants the attempt to produce a structure to carry it out, but very often the complications more than neutralize the supposed advantages of the proposed structure.

22 It is well known that the losses in a gas engine occur largely at the beginning of its stroke, while the charge is at its highest temperature and pressure. These losses are due not only to leakage, but to heat loss. It would seem, therefore, that the quicker the power could be utilized the greater the economy to be secured. With this idea in view I devised a link motion for the connecting mechanism, which could be arranged to give an extremely high speed at the beginning of the stroke and a slower speed at the end. Such a device is illustrated in Fig. 5.

23 A study of this motion will demonstrate the fact that by shortening the connecting rod A the speed ratio of the piston at the beginning of the stroke can be increased two or three times. In order to avoid side thrust upon the members, the link B is used.

24 The difficulties of this design lay in the greater number of bearing parts to keep in order, and also in the fact that any gain in increased speed was at the expense of increased pressure upon the crank pin. It was necessary, therefore, to use larger connections and larger shafts for a given size cylinder, and the difference in economy did not appear great enough to pay for the additional parts and their maintenance; the idea has therefore been abandoned after test. It seemed that all that could be obtained in this way could be gained by a longer stroke engine or an increase in the number of revolutions. I have seen this idea exploited by other parties since, but it has never attained commercial value. I think it may be laid down as a rule in the designing of any kind of mechanism that the idea should be a simple one and that any departure toward complexity is a mistake.

25 As gas engines increased in size, it became more and more difficult to start them by the old method of turning over the fly wheel by hand. Various devices for this purpose were tried out and apparently are tried out again and again by new inventors. One method was to introduce a charge of combustible mixture into the cylinder by a hand pump, and after the piston was started to ignite the charge and then expect the engine to continue operations from the one impulse. Such a method can be made to succeed, but often a single impulse will not drive the engine with sufficient speed to take in the next charge, in which case the operation has to be tried over again.

26 Another means tried by the author and used by others is a cartridge containing an explosive, such as gun-powder, obtaining the first impulse by the explosion of this charge. Such a device has the same fault as that of the first, the use of a combustible mixture, and the additional fault that the products of combustion are usually dirty and tend to fill the cylinder with particles of matter that may give trouble in the regular operation of the machine.

27 Starting by compressed air, however, has seemed to fill the required conditions, offering the simplest method of obtaining the

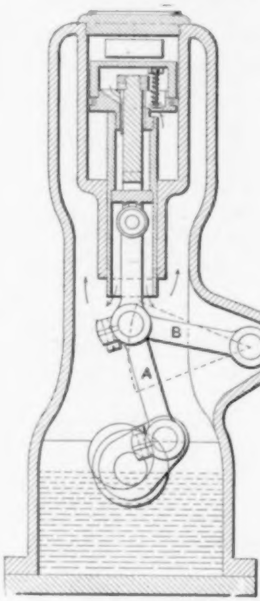

Fig. 5

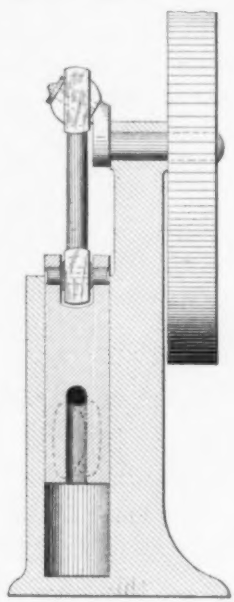

Fig. 6

Fig. 5 Engine with Accelerating Piston
Fig. 6 Piston with Combined Reciprocating and Rotary Motion

desired momentum of the engine. The only objection to this method of starting is in the cost of mechanism necessary to carry it out, which is quite an item when dealing with small units but of very little importance when dealing with larger ones. This method was the one I had intended to use in marine engine work, and as soon as our engines were of sufficient size to require power starting, we made use of this method, having sought in vain for a less expensive one. It is probably the standard method to-day for all large units, and offers

a means of handling the gas engine in either direction with the same degree of certainty in starting and reversing possessed by first-class steam engines.

28 In connection with mechanical curiosities, Fig. 6 shows a reciprocating piston device arranged to have also a rotary motion, which at one time was used in small motors with the idea that the piston could be made to operate as its own valve for admitting and ejecting the charge. The difficulty with this idea consisted as before in the complication of parts, universal joints introduced at the crank end and the wrist pin end of the connecting rod, and also in another fact which I have never yet been able to understand—that is, that a plunger having this motion will wear out very much faster than a similar plunger running with reciprocating motion. As

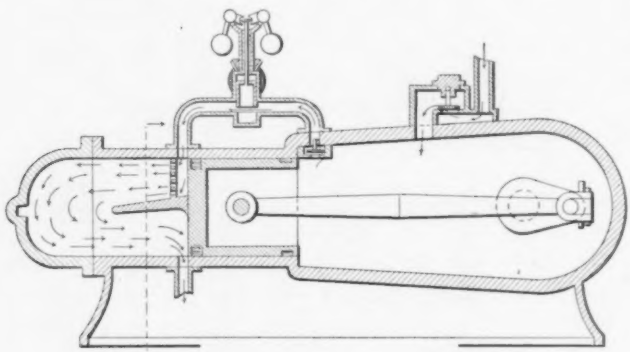

Fig. 7 Two-cycle Valveless Engine

a matter of fact, this combined reciprocation and twisting is just the motion which a mechanic uses in lapping out a hole with a lap, and it demonstrated its utility in this respect in the first machines made. I used the motion in a plunger valve for small motors, but soon abandoned it for the reason stated. The device has since been utilized in an oil pump for lubricators, and there it may not have the faults which developed when the attempt was made to use it as a piston for a gas engine.

29 The idea of a piston which would form its own valve still persisted and a two-cycle machine intended to use this principle is illustrated in Fig. 7. So far as I know, this is the first of the so-called two-cycle valveless engines, the charge being admitted and deflected at the end of the piston stroke so as to drive out the products of

combustion. Curiously enough, this broad idea has been developed into a multitude of forms, and there are now probably more people manufacturing small motors of this type than any other single type of gas engine structure. I freely confess that I did not appreciate the value of this idea at the time it was conceived, but confined my two-cycle work to the forms of structures in which mechanically operated valves were used. The evolution of the gas engine, however, has proved that the demand in small units was for simplicity rather

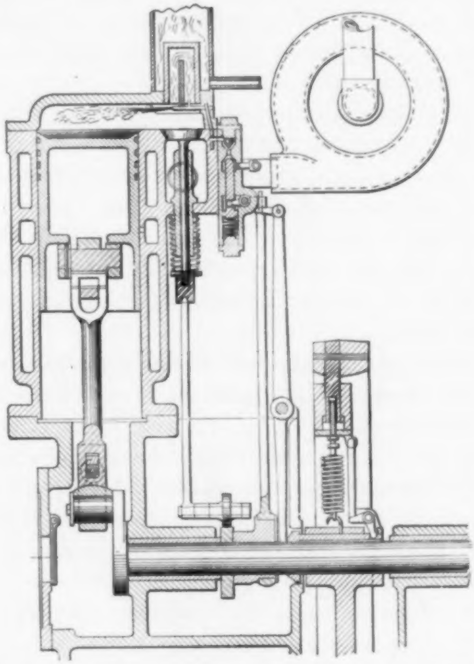

Fig. 8 High-pressure Engine—Fuel Introduced in the Form of a Spray

than for economy, and I did not realize this until others had proved it to be a fact. This leads one to quote the celebrated saying of Mr. Beecher, "If his foresight had only been as good as his hindsight, he would have avoided many mistakes."

30 Another device tested out and actually put in service, and closely on the line of the Diesel work of to-day, is illustrated in Fig. 8. This application was an old one and experiments were made very much earlier than the date of the patent. Fuel was ntroduced in the form of a spray or jet and burned in a volume of air,

the mixing being performed by the intensity of the flow of the gas itself. Cards taken from this engine can be made to assume either the form of the Otto cycle, wherein a practical explosion takes place; or the form of the card shown in the Diesel engine, in which the burning of the charge is slower, the whole depending upon the velocity of the jet as it enters the combustion chamber. If the jet is forced in with a very high velocity a complete mixture of gas and air takes place before the flame is communicated to the charge and a practical explosion is the result. If on the other hand the charge is allowed to enter with less velocity it will burn as it enters and impart a gradual heat to the charge. I do not know why I did not go further with this idea as it had many features of advantage.

31 The difficulty of ignition was still present in those days, the hot tubes which I used for ignition giving trouble with high pressures. If the present electric igniter had been available the engine would have proved a commercial success. But I had spent much time on this engine and our company demanded an engine which could be sold and produce revenue; I therefore felt it necessary to come down to some simpler forms and make engines for the market, rather than to seek to develop broadly new ideas.

32 In the evolution of a device like the gas engine, the tendency is to assume certain fixed and definite forms, which are usually determined by the factors of simplicity and ease of maintenance. When all possible variations are designed and tried out, there comes a time when designers revert, by a sort of mutual consent, to a certain type. The vertical form of engine now seems to have taken the place of most others for moderate sizes. The two-cycle valveless engine still maintains its position for very small powers; while the two-cycle engine with controlled valves has been widely adopted for larger units. The double-acting form of device is naturally the one which requires the greatest amount of care in design and construction; but its advantages have led to its use in units of considerable power. Thus each particular type seems to find a little nook for which it is better adapted than the others, and a war of types still goes on, showing that the gas engine art is still in a mobile state.

33 The principal work of engine designers of later years has been the perfection of a simple form of structure which has proved itself as having in the long run the qualifications of durability and economy: so many builders are now making vertical engines in which the main features are similar that no one has a field all to himself, the differences consisting rather in the arrangement of operating mechanism

and methods of economical mixing and igniting of the gases of the charge. The structures we are now making have mechanically operated valves guided in long bearings so that wear is imperceptible. The causes of premature ignition are now better understood than formerly. They depended upon conditions which were overlooked in the details of construction; a small part which could get unduly heated, or a portion of the combustion chamber not sufficiently provided with water jackets, was sufficient to cause premature ignition and prevent the highest economy which could be secured only by increased compression of the charge.

34 The pressures now carried are, on the average, double that which used to be the maximum in the Otto engine for city gas and four times as much as for producer gas. This has resulted in higher economy. The structures are also much more massive, or at least the metal is better distributed in relation to the work which it has to do. Methods of lubricating by the use of force feed apparatus make it possible to distribute the oil to those portions of the mechanism where it is absolutely needed, and improvements in the igniting apparatus have increased the reliability of operation of the machine.

35 The igniter has always been the weak point of the gas engine. My experience has shown that if the spark is intense enough the lighting of even a weak charge can be secured with a high degree of quickness. The method of advancing the spark to a new position seems to me unnecessary. There is always a minute interval of time after the spark has been made, while the surrounding mixture is being heated enough to transmit the flame. After the transmitting medium has once begun to flash, the time interval is extremely small. The lost time, therefore, is in that hesitancy of the mixture to light when a comparatively weak spark is used. It is, therefore, necessary to allow a certain interval when a weak spark is used, depending upon the weakness of the charge, because the particles nearest the igniter cannot instantly give out sufficient heat to transmit the flash into the charge. On the other hand, if the spark is so intense that it produces enough heat in itself to start the preliminary flame, the time of hesitancy can be made to disappear almost entirely, and the flash will be communicated with almost equal speed in any mixture available for power in a gas engine. The necessity for providing higher power in the igniter is being more and more clearly recognized by engine builders and we can now obtain mechanism for ignition of higher power than that formerly available.

36 This brief description of some of the ideas that I have seen

tried out is offered in the hope that it may serve either to suggest ideas to those looking for improved devices, or perhaps to deter others from beginning experiments in lines which have already proved unsatisfactory. Ideas are constantly being repeated by men who have not come into contact with each other, each thinking himself the originator, and so the same experiments are often gone over and over by different people with much loss of time and money.

The numbers and dates of the United States patents to which reference is made in this paper are as follows: 278 255, May 22, 1883; 334 035, January 12, 1886; 312 498, February 17, 1885; 289 019, November 27, 1883; 378 847, February 28, 1888; 386 211, July 17, 1888; 583 627, June 1, 1897.—Editor.

GAS POWER SECTION

DISCUSSION UPON REPORT OF CHAIRMAN OF THE MEETINGS COMMITTEE

MEETING OF OCTOBER 13

Mr. H. H. Suplee I had the opportunity of going over this report with the chairman of the Meetings Committee at the time he prepared it and I think perhaps a few words upon the various headings may help to bring out the ideas that he was anxious to express.

2 In the first place it is very important that the Meetings Committee have the assistance of all the members of the Section. The chairman has already impressed you with that fact and it is not necessary to add anything more.

3 The subject mentioned in Par. 8–11 is one which is particularly important and which ought to be impressed on all the members, and I hope discussed tonight, and that is the reputation of gas power. The principal obstacle which gas power has to encounter at the present time is the rather dubious reputation for reliability—or rather the reputation for unreliability, which it now has. Yet there are now many excellent power plants at work, and we want all the members who possibly can to add to the record by telling either by name or by fact what they know of reliable and satisfactory gas-power plants now in operation, in order to offset the ill-repute of the few that have not been working well.

4 The other point which is particularly important is that the Section shall be the means of collecting a full record of the literature of gas power to date. Several members of the Section are already prepared to contribute their own card indexes of articles and of bibliography, as well as of patents and of plants in operation, and any member willing to do that or willing to say anything about it will be able to do good work for the Section. We want to get all this information on record here in the home of the Society, so that the Secretary of the Society may be able to furnish it to any one who may ask for it.

5 There is also another question which may be brought up; and that is the comparison between steam and gas power plants, not the rivalry, but the adaptability of one or the other. That is a subject which should be considered for future papers and discussions.

6 Another matter closely allied to the keeping of a record of gas power plants here is that the Society shall aid its own members and others in avoiding duplication of work which has already been done, so that if a man wishes to take up any subject in connection with gas power he can come here and find out how much has been done already, instead of discovering later that the same work has already been done before, and possibly found not altogether profitable or desirable. Further subjects which are certainly applicable for discussion are, the application of gas power to marine propulsion and train propulsion; also methods of cleaning gas and measuring it in carrying out the necessary tests, a matter touched on still more fully in the papers presented before the Standardization Committee. Discussions upon these several subjects are especially desired now by the chairman of the Meetings Committee to guide him in preparing the work of the Section.

Mr. G. M. S. Tait In Par. 23*a* Mr. Doherty mentions as the peculiarity of the gas engine, as compared with the steam engine, that the gas engine has its highest efficiency at its maximum load, the steam engine at some intermediate load. Now in this regard it would seem that a very satisfactory arrangement for large plants would be the combination of steam for the varying load with a producer gas installation for the steady load. Information as to practice along this line would be of great help to all of us. For example the ordinary trolley and electric lighting systems show excessive peak and comparatively small average load, and the gas producing proposition would probably work economically for the uniform load, while the steam turbine, for example, could be used to advantage for the peak. It would be a good deal of assistance to all the men in this business if we could have data as fast as they are obtained, giving us actual information as to the economies obtained by such combinations in actual practice.

2 Another point on which we need more information is in regard to continuity of operation. Hitherto in operating plants for more than eight or ten hours at a stretch there has been considerable difficulty in cleaning the fire without interfering with the uniformity of the gas. There are two causes for this trouble: First, the barring down and

cleaning out of the clinkers is apt to form blow-holes up through the fire which will seriously interfere with the quality of the gas generated, causing an excess of carbon dioxid—that can be taken care of by having a sufficiently large fuel area so that the draft is not excessive in any one spot; then the question of ash removal without causing the same defect, and this can be handled with a water-sealed grate or some form of grate that is cleanable in sections.

3 Any information on the lines of 24-hr. runs and continuous runs would be very interesting. In a plant over in Long Island City with which I am connected we have been able to operate 24 hr. a day whenever we wished and for as long a period as we wished, simply because the draft balance is so arranged by using the pressure of the exhaust in the ash pit that practical atmospheric condition can be produced in the producer when the cleaning is desired. This is a very simple means of handling the proposition.

4 The economies in cost of operating continuously show so very high in comparison with short spasmodic runs as to make an even more satisfactory comparison with steam in long than in short tests. For example, you can operate in some cases on 7/10 lb. of coal per b.h.p. when running continuously at full load, whereas the coal consumption is $1\frac{1}{4}$ to $1\frac{1}{2}$ lb. in operating 10 hr. a day at a fluctuating load. In making guarantees it would be of great assistance if we could know in advance just what the number of hours of operation are to be and whether cleaning periods are to be periodical or intermittent.

5 Another plant which came to my notice this summer was out in Olympia, Washington. There we installed a 300-h.p. down-draft producer operating on lignite fuel. That plant has now been operating for almost three months, 24 hr. per day at a slight overload. No shut downs of any account. This is also accomplished by having the draft balance sufficiently under control to enable the removal of ashes and so forth without causing undue gas fluctuation. If we can all tabulate results of this kind we will have a much better set of arguments to present to steam competitors.

6 In Par. 28 Mr. Doherty calls attention to the unpromising fields and unnecessary duplication. Many of us I am sure have worked along the same lines of research, which would not have been necessary if we had been a little bit more communicative to fellow workers. I think it would be a very good suggestion if the various men in the business here were to tabulate their troubles and advise the Society of the remedies. Then we would not all be going through the same process of research in each individual case.

Mr. D. B. Rushmore The suggestions made in this paper regarding the possible work of this organization duplicate in many respects ideas of my own. A more or less definite working plan is very desirable in starting such an organization, and such a plan of action is, if I understand correctly, the subject of discussion, and not any of the particular features here outlined.

2 Those familiar with recent discussion on the gas engine situation realize the uncertainty which exists concerning the actual results being obtained. Probably one of the most important things for this Society to do is to standardize gas engines so that the rated output may be expressed in figures comparable with each other. Not much general information exists in this country on the subject of the washing of gases and experience with gas engines on blast furnace gas in this country is comparatively recent. It is difficult to get reliable information regarding foreign installations, and confidential reports on this subject differ much from general publications. The subject of the relative cost of power from gas engines and steam turbines where the power in both cases comes from blast furnace gas is an active one, and is by no means in favor of the gas engine in all cases. Gas engines have not been used in this country to drive rolling mills as they have been to some small extent in Europe. The parallel operation of gas engine driven alternators is also a subject needing some investigation.

3 If this Section is to attain the success which it should great care should be used to see that the facts here brought out are thoroughly reliable. The telling of but half the story is usually one of the greatest handicaps in any new development.

4 There is a very large problem in the anthracite regions of Pennsylvania awaiting the solution of a suitable producer. The culm piles are a great possible source of energy which can supply power for the mines for many years to come if the necessary apparatus can be designed.

5 I would disagree with the report with regard to including the gas turbine in the unpromising fields. A modified gas turbine is a promising field and some day it is hoped that such a machine will be in operation.

Mr. M. R. Bump There are one or two points on which the work of this Section could, I believe, be made doubly valuable to the operator of producer plants. We often hear it remarked that it is very difficult to find good practical producer operators, or good practical

gas engine operators, and in order to determine the difference between good and poor men we must obtain a great number of practical data upon the operation of engines and producers. We must put these data in plain enough language so they can be used to develop more operators, and endeavor if possible to standardize the operation so that the gas engine or producer operator may come to belong to a recognized class of skilled labor, as is the steam engineer.

2 Along the line of securing this practical information there are two plans which could I think be combined into one and which would prove of considerable value.

3 I don't know whether you are all familiar with the Question Box system of handling such points. In some of the gas associations and in the National Electric Light Association, any member of the association may ask questions along the line of the practice of the industry and the editor handling the question box sends out these questions to the membership and requests answers from as many as are willing to contribute. In that way a great many points have been brought out, and a great deal of information which is valuable but not of enough importance to put into a paper has been gotten together, and the results have been material increase in the fund of information along the line of practical work. Such a question box is in a measure automatic in its indexing. By this I mean that the subjects are easily indexed by looking through the list of questions.

4 The National Electric Light Association has recently devised a new plan for a question box, which is now carried on in their monthly bulletin to members, in which are a number of short articles on different topics and general association news; each month the list of new questions received during the month is published and the following month answers to the questions are printed and the new series of questions which have come in during that month. If no replies are received the questions are repeated another month, in the hope of securing answers.

5 It seems to me that some means of this kind could be put together in suitable shape as the work of this Section develops. The practical information would be of great assistance to those engaged in operation work or who have charge of the training of plant operators.

6 The other plan is the so-called Wrinkle Department carried on by the same associations, which secures any sketches and plans of novel ideas tending to improve the practice in any branch of the industry which the members are willing to contribute for the use of other members. In this department little stunts for the control of the vari-

ous pieces of apparatus, etc., are presented, and a great many valuable devices have been brought out.

7 I would suggest that in the case of the Gas Power Section these two departments be combined under the direction of an editor, or a board of editors, if deemed very advisable, and I believe that these departments would prove most beneficial to all members of the Gas Power Section.

Prof. S. A. Reeve I also would like to say a word in favor of the unpromising fields of gas engine endeavor against which Mr. Doherty has attempted to warn the Section. The particular unpromising field in which I am interested is the outside-compression gas engine, of which there are many different types. Viewed in these broad terms, the class has existed for a long while. Clerk, I think, in 1876, was the first man to build an outside-compression engine, and patents for outside-compression engines run away back beyond the date of the first commercial gas engine construction. No one to date has produced a successful outside-compression engine; and yet we are still trying. I recall that when I first started in, one of my chums, now a prominent member of the Society, dubbed my efforts by the generic name of "fizz-go-whang," implying that the first effort would be a fizzle and the second an explosion. Well, both results were accomplished. He also referred to them as my flying-machine efforts, implying their futility: but the flying-machine has won out, and the outside-compression gas-engine is still in abeyance.

2 Inventors cannot get away from the idea of outside compression; and unquestionably there are attractions in that plan which are almost beyond estimate. For instance, in this comparison between steam and gas power, the inflexibility of the explosion type of gas engine to carry load has been brought out. The outside compression engine at least in two or three types, is just as flexible for overload as any steam engine, and perhaps even more flexible in that respect than the compound steam engine, promising ability to carry very great degrees of overload with no great diminution of efficiency. The characteristics of the outside-compression engine are like those of the steam-engine, the dynamo, the steam boiler and all other pieces of engineering apparatus except the explosion-engine, namely, that their maximum efficiency is reached before the maximum load. Thus any such engine can be operated under actual conditions in the region of its best efficiency; whereas the conditions of operation always force the explosion type of engine to be operated under a middle field of

load, where the efficiency is far below the best that can be actually produced in the engine.

3 Reference has been made to the gas turbine. It is my opinion that we shall never have a gas turbine until it is developed in one of the outside-compression types, and that rests of course on the turbo type of compressor for the lower stages of compression. We have already brought into practice the combination of the piston engine and turbine in marine propulsion: the piston type for the high-pressure and the turbine for the low-pressure stages. The outside-compression cycles for gas engines lend themselves easily to that combination: the use of turbine types of both compression and expansion for the lower stages, where large volumes and low pressures are the rule, and the piston type for the higher stages of both compression and expansion, where smaller volumes and very heavy pressures are the rule.

4 Another paragraph of the report speaks of marine propulsion. It is my personal opinion that marine propulsion by gas power will not go very far before it adopts the outside compression engine.

5 The service of rolling mills has also been mentioned. The outside compression type adapts itself beautifully—on paper, of course—to rolling-mill service. Its readiness for reversal and for the heavy margin of power that I have just mentioned adapts it to rolling-mill problems.

6 Now the term "outside-compression engine" is a very broad one, and includes designs of machines most diverse in mechanical construction. Which will be the successful one it is today impossible to say, but considerable progress has been made. We have gone far enough to learn why the outside-compression engines cannot succeed, or have not succeeded at the present time; and those obstacles are just such as formerly beset the compound steam engine, for instance, which could not get down to actual practice for many years after it was invented and found operative. We see our way toward a date not very far in the future, when these obstacles will be very much minimized. It seems to me, therefore, that the general field of gas-engines of the outside-compression type should be a legitimate one for the attention of a special Section of this sort, and I hope that this will be done.

Dr. C. E. Lucke There have been two references to gas engines in rolling mills. About three years ago I personally saw in the Krupp works at Rheinhausen a large gas engine directly connected to a three-high roll, rolling rails and apparently doing good work.

2 A class of information about which we should interest ourselves and which was not mentioned in this report, I would like to have recorded—that general class of exact scientific fundamental information. We need not only all the things that have been mentioned but more. We need exact information on the specific heat of gases and how the specific heats of gases vary with conditions; a problem on which our British friends have spent a great deal of time and energy and considerable money. We need a great deal of information on the properties of liquid fuels, the specific heat of the liquids and of the distillates, the latent heat of distillation, the particular functions tying together these physical properties, and the temperatures and pressures. We need also information on the conditions causing decomposition of hydrocarbons, hydrocarbons in the form of gas, volatilized from coal or hydrocarbon vapors from liquid fuel. We have very little information on these points; yet there is scarcely a producer or an engine problem that does not bring us today face to face with that stone wall of no information.

3 The general problem of gasification is not scientifically set down anywhere. We are building producers but do not know what is happening in the producers. Of course something is known in a general way, but the exact solution will not come until we have precise information. At what temperature does carbon dioxid begin to take up more carbon and become carbon monoxid, and how fast does it happen; how does the rate of the reaction change with the temperature, the time of contact, the condition of or kind of carbon, in general or in its surface condition; how does a little film of ash over the carbon affect the rate? These certainly are problems in producer design. I would suggest then a great deal of information of the exact scientific sort which is basic and fundamental and which has not been mentioned.

Mr. C. T. Wilkinson Does it not seem desirable that we should round up the present situation of gas power in this country, in so thorough and comprehensive a way that we may not only know exactly the basis on which the industry now stands, but may be in a position to know how best to aid it to develop, and to know from what quarter papers of value may be expected for presentation before the Society? Further, a greater knowledge of the standing of the industry seems fundamental in the attempt to grapple with the numerous other problems which must be faced. With this end in view, therefore, I would respectfully submit the following suggestions:

a That a complete list of all the Gas Engine Plants in the United States, with apparatus installed, etc., be circulated among the members of the Section, or possibly published more widely. Such a list has already been prepared, I believe, by one of your members.

b In addition to the above, a committee should be appointed whose duty it should be to prepare a definite schedule of questions to be forwarded to each of these stations with the object of finally preparing a report similar in nature to the steam turbine report presented annually to the Association of Edison Illuminating Companies by their Turbine Committee.

c Whereas the development of the large gas engine plants (containing units of 2000 h.p. and upwards) is being watched with extreme interest, it would possibly be desirable for the committee to visit them personally and prepare a supplement to the above report.

d In addition, would it not be wise to have the Committee prepare a form of power house record sheet, giving in a convenient, concise and thorough form all the essential points which should be recorded in the operation of a gas power station? This schedule, prepared by the Gas Power Committee and recommended by them, would no doubt be widely used by power plant operators, and enable us eventually to issue standard recommendations on certain features of the subject.

2 You will see that the object of the above suggestions is to bring those who are frequently asked for information on gas power work (among them myself) into a position where they are able to give sound advice, and by increasing the knowledge and thus the confidence of consulting engineers, it would lead to a more rapid development of gas power work. This, of course, will be only a small part of the very valuable work which your Section can undertake, but since it appears to me as the first step to be taken, I take pleasure in hoping that it may be of some use to you. Should such a scheme be followed out, I should be most happy to offer my services in the preparation of schedules or in any other way.

DISCUSSION UPON PROGRESS REPORT OF COMMITTEE ON STANDARDIZATION

MEETING OF OCTOBER 13

Mr. Charles W. Lummis The term in which to express the heat value of the gas is one which has good arguments on both sides. The chief claim of those holding that the so-called effective heating value of the gas to be used, is that it is necessary to have some unit which will express the efficiency of the engine, irrespective of the composition of the gas used. They say, and very justly, too, that if the engine efficiency is expressed in total B.t.u., the information applies only to the particular gas on which the test was made. There would be great confusion in guaranteeing and comparing efficiency of gas engines using fuel of the widely varying composition found in practice.

2 I believe this is a fair summary of the most forceful argument advanced in favor of using the lower or net heat value of the gas in such computations. In my estimation it is very necessary to have some such basis for the comparison of engine performances, and I have no doubt some means will be found for accomplishing it.

3 On the other hand the advocates of the actual or total heat value of the gas argue from a strict interpretation of what the term "efficiency" means. They say if the gas engine cannot use the latent heat due to the burning of hydrogen, this is simply the lack of efficiency of the gas engine. It is equally true that gas engines as built now cannot utilize the sensible heat of the gases below 1000 or 1200 deg. fahr., at which temperature they are exhausted from the cylinder.

4 This loss is much greater than the loss due to the latent heat of the steam formed, and if the engine is to be given an allowance in one case, there is no reason why either allowance should not be made.

5 It is conceded in steam engine practice that a large proportion of the heat units supplied the engine are not effective for doing work; the efficiency of the steam engine, however, is based upon the total heat supplied the engine. In pumping engines, for instance, the

rules formulated by this Society provide for the duty to be stated on the basis of 1 000 000 B.t.u. in the steam supplied the engine. No correction is made for the heat which is not effective in doing work, so the duty is figured on actual and not effective B.t.u. in the steam.

6 In testing steam boilers the efficiency is based on the total heat of the steam which is raised, and not upon the heat which might be effective in the steam engine for doing work. The testing of gas producers and gas engines, it is argued, should be on this same basis.

7 I am strongly in sympathy with this view, and believe that in testing a gas engine and producer plant it is entirely unscientific to base the efficiencies on the so-called heat value of the gas.

8 Further, it would appear to me to be a dangerous precedent, and one which would leave open the way to other arbitrary corrections and allowances, to increase the apparent efficiency of both this and other forms of apparatus.

9 After having given the subject of reconciling these two views considerable thought, it seems to me every end would be served by expressing all quantities involving the heat value of gas in terms of the actual or total B.t.u., accompanied by an expression which would denote its relative value for power purposes. This expression should be the ratio of the total to the net heating value, and for want of a better name I suggest calling it the "Power Factor" of the gas. Thus, assuming the total heat value of a certain producer gas is 140 B.t.u., and the net heating value 132 B.t.u. per cubic foot, the "Power Factor" then would be $132 \div 140 = 94.3$.

10 The producer efficiency could then be expressed as follows: Efficiency of producers = 80 per cent with gas of "Power Factor" 94.3. The engine could then be stated as requiring 11 000 B.t.u. per b.h.p. hour; gas "Power Factor" 94.3.

11 These engine data would always be available for comparison with other tests, and the efficiency of the engine on any other gas would at once be known, if the power factor of that gas were known. On a gas containing no hydrogen, and having a "Power Factor" of 100, the engine would require $\frac{94.3}{100} \times 11\,000 = 10\,373$ B.t.u. per b.h.p. hour; and on natural gas, power factor 90, the heat consumption would be $\frac{94.3}{90} \times 11\,000 = 11\,528$ B.t.u. per b.h.p. hour.

12 It will thus be seen that this form of expressing these quantities is flexible in converting the performance from one set of conditions to another, and at the same time the actual efficiency of the engine

is expressed for each particular case and quantities involving an impossible condition of heat value of gas are avoided. Below will be found a table giving the characteristics of some of the power gases with their power factor.

Name of Gas	ANALYSIS BY VOLUME							B.t.u. at 60 deg. fahr. per cu. ft.	"Power Factor"
	CO_2	O	CO	CH_4	Ill.	H	N		
Blast Furnace...........	11.5	.....	27.5			1.0	60.0	92	99.2
Producer Anthracite.....	7.0	.....	24.0	1.0		12.8	55.2	130	94.4
" "	5.6	0.6	25.4	1.0		17.0	50.4	148	93.5
" Bituminous ...	7.9	.....	23.4	2.1	0.4	17.1	49.1	158.9	93.5
Illuminating gas.........	1.5	0.5	8.6	31.4	4.0	51.5	2.5	599	89.7
Natural Gas.............	0.3	0.2		98.3			1.2	993	90.0

13 With reference to the method of determining the efficiency of gas producer proposed by Mr. H. F. Smith, and printed in the September number of The Journal, there is no doubt that if one could assume the analyses of both coal and gas to be correct, this method would be reliable and accurate. The method, however, is one which leads to great errors if these analyses are not correct, and it has been my experience that a large proportion of the gas analyses which are published are incorrect.

14 It is almost universally the case that the carbon monoxid has not all been absorbed, which also makes the hydrogen appear greater than it actually is. This error does not materially affect the heat value of the gas as calculated from the analysis and compared with the results obtained from a Junkers calorimeter. It, however, does affect seriously such a calculation as Mr. Smith proposes, as the weight of carbon per cubic foot of gas is less than it should be, which results in an apparently large number of cubic feet of gas per pound of coal, and consequently a higher efficiency.

15 I have checked over the figures which Mr. Smith included in his paper, and will call attention to some results which I think will illustrate my point.

16 Assuming that in the gasification in question all of the carbon in the coal were burned; in other words, that there were no carbon in the ash, there would be produced $0.832 \div 0.00949 = 87.7$ cu. ft. of gas per pound of coal gasified. The quantity 0.832 is the weight of

carbon per pound of coal as given, and the figure 0.00949 is the weight of carbon in each cubic foot of gas as given. The figures in Mr. Smith's table are based on gas of 32 deg. fahr. The heat value of the gas per cubic foot given as 135 B.t.u. in the paper is the low heat value. The total heat value of the gas at 32 deg. is about 147 B.t.u. If there were produced, then, 87.7 cu. ft. of gas per pound of coal, the gas being of 147 total B.t.u. per cubic foot, the total heat in the gas per pound of coal would be 12 892 B.t.u. As the calorific value of the coal is 12 485 B.t.u., it will then be seen that the efficiency of conversion of the producer is 103 per cent. This, of course, is an impossibility, as it involves the assumption that more heat is introduced into the producer through the steam and air blast entering at the bottom than is lost through radiation and sensible heat of the gas leaving the producer.

17 If the method of dividing the total carbon in the coal by the carbon in the gas, to obtain the cubic feet of gas produced is resorted to, no results should be accepted which will not bear a complete calculation as to all of the elements found in the gas. That is, after having obtained a number of cubic feet of gas produced per pound of coal, as described in Mr. Smith's paper, the total weight of all of the elements in the gas should be calculated on the basis of the number of cubic feet of gas as determined. From the weight of these elements should be deducted the weight of the elements which are in the coal. The remainder will represent the weight of the elements introduced by the blast into the producer. These should then be susceptible of balancing. In other words, from the weight of oxygen there should be deducted eight times the weight of the hydrogen. The balance will be the weight of the oxygen which was introduced by the air. This quantity, when multiplied by 3.32, should correspond closely to the total weight of the nitrogen found in the gas. If this does not balance it is certain that the analyses are not right, in which case the method of figuring the efficiency of the producer as proposed by Mr. Smith would not be accurate. I have checked over the figures given by Mr. Smith, along the above lines, and the discrepancy is very great.

18 The subject of correct gas analysis is one which the committee should investigate very closely, as it is one of the details connected with the gas producer and gas engine business which, as generally practiced, is very crude, and as I have stated above, the percentage of errors is very large indeed. I believe that the method which Mr. Smith has presented is a very good method if properly handled, but

unless ample precautions are taken to protect the use of such method, erroneous results will be very numerous and lead to considerable confusion.

19 In making a test of a large plant the method of measuring the gas by Venturi tubes or Pitot tubes can be resorted to with a very high degree of accuracy, especially where the readings of the instruments can be calibrated by the dropping of a gas holder.

20 In regard to the question of the rating of gas producers, considerable stress has been laid upon the grate area, or cubic foot of fuel body per horse power. While this is an important consideration, it is not fair to rate producers entirely on this basis. In anthracite coal the operation of a producer is dependent just as largely upon the ability to get rid of the ash. Several cases have come under my observation where a producer of the same cubical contents and area was enabled to do 50 per cent more work by the installation of improved means of removing the ash. It is possible, therefore, for some producers to operate economically and with higher efficiency and small attention, on a gasification of 13 lb. of coal per square foot per hour, while other producers having less well worked out methods of removing the ashes cannot operate efficiently on a gasification of 8 or 9 lb. of coal per hour.

21 In bituminous coal practice, besides the question of ash, there also arises the question of the physical characteristics of the coal, such as its caking and coking qualities, and the percentage of sulphur, etc. These all influence the quantity of coal which can be readily gasified per square foot of the producer, and I am raising this point because I believe that the rating of the producers should not be entirely a question of the square feet of gasifying area, but should also take into consideration the design of the producer.

Mr. J. R. Bibbins Concerning this question—whether the total or effective heat value should be employed in gas power work as a standard for computing engine and producer efficiencies—I feel that the arguments presented in favor of total heat value are by no means conclusive. From a purely theoretical standpoint, there may possibly be greater consistency in considering the latent heat of vapor formed in combustion as a positive factor in the production of work; but in practice I am unable to recall any instances in which this vapor is instrumental in increasing the useful work.

2 Considering the internal combustion engine as it is to-day, we are confronted with the problem of establishing some standard by

which the performance of engines of various types may be compared. If we permit the introduction of a variable factor, or otherwise indefinite expression of efficiency, all will be chaos, and at the present time we are painfully near such a state. The use of "total value" at present not only compromises the engine builder in his endeavor to attain a definite standard of efficiency, but most important, introduces a factor entirely beyond his control and one that *varies with every make of producer, every kind of fuel, and is not even constant from hour to hour* when operating under constant load conditions.

3 I will cite two instances which appeal forcibly to my mind: first, the case of a blast furnace gas engine. Under normal operation, there is practically no hydrogen in the gas, but occasionally a leaky tuyere results in a severe dose of hydrogen at the engine, and hence, a lower heat value. I fail to see the propriety of considering the inherent efficiency of the engine momentarily reduced to any degree by the presence of this hydrogen.

4 Second, the case of a suction producer with internal evaporator delivering an abnormal quantity of vapor. Is the engine efficiency for the time being decreased? Why should the engine be penalized for conditions which are decidedly local and extraneous to its operating cycle. The essential object of any standard is to divorce as far as possible the effect of variable local conditions from an otherwise definite and invariable quantity.

5 I cannot help but notice that builders of gas power apparatus are the most emphatic in advocating total heat value. But is this position entirely logical? I would ask if there is a single commercial application of producer gas in existence in which the latent heat of vapor formed by combustion is utilized to any advantage. In power work, it is unavailable. In heating work, it is equally so, although the advantages of a high hydrogen content in producing high combustion temperatures, may more than over-balance the lower producer efficiency obtained.

6 Now there is no reason why an expression may not be adopted which would meet the desires of both parties—the engine and the producer builder, and some term should unquestionably be adopted. In the case of an overall plant guarantee based upon coal consumption alone per unit of useful output, there will, of course, be no question of heat value involved, but if the producer builder adheres to total value and the engine builder to effective, the unsuspecting customer is obliged to juggle the balance, usually to his loss. The ambiguity of the generic term "heat value," should not constitute a disguise for inefficiency.

7 The term "power factor" has been suggested as the ratio between effective and total heat value. This suggestion, however, is somewhat belated, as "power factor" has been in use for some time to express ratio between power that may be developed with a poor gas as compared with a rich gas in the same sized engine. Thus, assuming natural gas as a standard (100 per cent) a gas engine working on blast furnace gas with the same cylinder displacement could develop only 70 to 75 per cent of its rating; in other words, its power factor would be 75 per cent. And owing to the established use of the term "power factor" in electrical work, it would seem undesirable to appropriate the term for another purpose. "Effective power value" has also been suggested, which seems to be more desirable, and in fact, if adopted, might be soon recognized by the abbreviation e.p.v. as e.m.f. in electrical work. This term is definitely associated with power production and leaves the builders of heat and lighting apparatus free to continue the use of "total heat value," if desired.

8 Finally, I disagree with the statement that all manufactured gases contain more or less hydrogen, either in nascent or combined form. This is only partly true. It is entirely practicable to generate gas containing no hydrogen; e.g., blast furnace gas, or producer gas by the Thwaite process, i.e., with no steam blast. This gas may be utilized with just as high an efficiency as gas of twice the heat value. Now if in the nature of our producer process we *must* manufacture a gas containing hydrogen of widely varying percentages, is the engine designer at fault because he is unable to utilize the latent heat of combustion? By no means. On the other hand, the steam gas is actually employed for two definite purposes. First, keep the temperature of the producer furl bed below the clinkering point; and second, to obtain as high a rating as possible from an engine of given dimensions. These are the practical aspects of the subject. I do not believe that the simply theoretical aspect above-mentioned should unduly influence us when adopting a standard which involves certain confusion in commercial work.

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EMPLOYMENT BULLETIN

The Society has always considered it a special obligation and pleasant duty to be the medium of securing better positions for its members. The Secretary gives this his personal attention and is most anxious to receive requests both for positions and for men available. Notices are not repeated except upon special request. Copy for notices in this Bulletin should be received before the 15th of the month. The list of men available is made up of members of the Society and these are on file, with the names of other good men not members of the Society, who are capable of filling responsible positions. Information will be sent upon application.

MEN AVAILABLE

176 Junior, graduate M. I. T., married, desires position as assistant to manager or superintendent of large factory. All-around experience in large manufacturing establishment, including two years machine shop practice and shorter periods in the foundry and cost departments. At present employed as chief engineer. Thoroughly familiar with the installation and management of direct current power plants.

177 Junior member, age 30, desires to make a change. Technical graduate, five years designing, erecting and operating horizontal steam turbines. At present inspector of turbine power stations. General power house and electrical work. Desires position as assistant to general manager or superintendent of large power station, or in office of consulting or contracting engineer.

178 Junior, graduate mechanical engineer, whose training and experience has fitted him for chief engineer of large power plant (turbine plant preferred) or assistant to superintendent of central station or traction company, desires change.

179 Junior member, six years experience in mill construction, designing special machinery and layouts of plants. At present, assistant manager of an engineering concern.

180 Mechanical engineer, technical education, eight years experience, four years in charge of draftsmen designing power plants, industrial plants, and special machinery. One year as superintendent of construction, familiar with business methods and management of industrial plants.

181 Member, technical graduate, mechanical and electrical engineer, 13 years experience covering drafting room, engineering office work and operating steam plant. Familiar with power plant design and general building construction.

182 Superintendent desires change. Well up in modern machine shop and foundry practice. Thorough mechanic with business experience.

183 Member, of ability, high standing and long business experience in New York and with foreign countries; good designer of factories, industrial plants and special machinery, desires responsible position with large engineering or contracting firm needing a mechanical man strong at overcoming engineering difficulties.

184 Electrical engineer, graduate M. I. T., having had experience in the operation of steam-electric power plants, high tension transmissions lines, electric railway equipment and office organization. Three years experience as general superintendent of light, heat and power company.

CHANGES IN MEMBERSHIP

CHANGES OF ADDRESS

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COLWELL, James Van V. (1903), Life Member, 1765 Sedgwick Ave., New York N. Y.

CONNETT, Lyndon Rutan (Junior, 1898), Pres. Crescent Sand and Gravel Co Port Washington, L. I., N. Y.

COOKE, Fred W. (1903), Mgr. Am. Loco. Co., and 384 Broadway, Paterson, N. J.

COOKE, St. George H. (Junior, 1905), St. George H. Cooke Co., Engrs., Cambridge Bldg., Chester, and 608 Morton Ave., Ridley Park, Pa.

COSTER, Maurice (1904), Mgr. Export Depts., Westinghouse Elec. & Mfg. Co., and Westinghouse Mch. Co., 165 Broadway, and 608 Riverside Drive, New York, N. Y.

CRANSTON, Raymond Earl (Junior, 1907), Asst. Engr., 815 Banigan Bldg., Providence, and 31 Lawn Ave., Pawtucket, R. I.

DALLY, John Horton (1903), Ch. Engr., N. Y. Stock Exchange, 10 Broad St., New York, N. Y., and 77 Glenwood Ave., East Orange, N. J.

DARBY, John Henry (1901), Civil Engr., Manor House, Brigg, Lincolnshire, England.

DAVIS, Charles Ethan (1896), Supt., Automobile Dept., Am. Loco. Co., and 272 Benefit St., Providence, R. I.

DE LAMATER, Oakley R. (1902), Secy., Mitchell Motor Co. of N. Y., 1876 Broadway, New York, N. Y., and Englewood, N. J.

DICKERMAN, Wm. Carter (1899; 1907), V. P., Am. Car and Fdy. Co., 165 Broadway, and 809 Madison Ave., New York, N. Y.

EPPLE, Edward C. (Junior, 1908), Asst. Mgr., Independent Engrg. Co., 50 Church St., New York, N. Y., and 250 Central Ave., Jersey City Heights, N. J.

FERGUSON, J. W. (1891), Engr. and Bldg. Contr., 152 Market St., and 12th and 28th Sts., Paterson, N. J., also 253 Broadway, New York, N. Y.

FIEUX, Ernest D. (Junior, 1907), V. P. and Genl. Mgr., Engrg. Supervision Co., 45 W. 34th St., and *for mail*, 200 Riverside Drive, New York, N. Y.

FOX, Sir Douglas (Honorary, 1900), Head of Firm, Messrs. Sir Douglas Fox and Partners, Cons. Civil Engrs., Cross Keys House, 56 Moorgate St., London, E. C., and Kippington Grange, Sevenoaks, Kent, England.

FRY, Lawford H. (1905), Tech. Rep. in Europe of Baldwin Loco. Wks., 56 Boulevard Haussmann, Paris, France.

GERRISH, William H. (1901), Supt., Travers Mfg. Co., 542 W. 52d St., New York, N. Y., and 787 Madison Ave., Paterson, N. J.

HELMES, M. J. (Junior, 1903), Ch. Engr., and European Rep., European Brake Shoe Co., 90 West St., New York, N. Y.

HOWELLS, Charles (1904), Supt., Watson-Stillman Co., 50 Church St., and 600 W. 142d St., New York, N. Y.

HUTCHISON, Cary T. (1894), Cons. Engr., 60 Wall St., New York, N. Y.

LANGE, Philip A. (1896), Genl. Mgr. of Wks., The British Westinghouse Elec. & Mfg. Co., Ltd., Trafford Park, Manchester, and Hurst Dale, Altrincham, Cheshire, England.

LIGHTHIPE, Wm. W. (1907), Engr. Sales Dept., Otis Elev. Co., 17 Battery Pl., and 145 W. 11th St., New York, N. Y.

MAIR-RUMLEY, John Geo. (1892), Messrs. Gwynnes, Ltd., 81 Cannon St., London, E. C., England.

MASON, Daniel A. (1899; 1902), 372 Stuyvesant Ave., Brooklyn, N. Y.

RENOLD, Charles Garonne, (Junior, 1906), Dir., Hans Renold, Ltd., Progress Wks., Manchester, and *for mail*, Priestnall Hey, Heaton Mersey, Manchester, England.

SNYDER, Robert M. (Junior, 1890), present address unknown.

STUNTZ, J. E. (Junior, 1903), Ch. Engr., Cape Cruz Co., Ensenada De Mora, Cuba.

TRAMPE, J. Adam C. L. de (1904), 1703 Spruce St., Philadelphia, Pa.

WILLIAMSON, George E. (Junior, 1906), Engr. of Wks., Union Metallic Cartridge Co., and 521 Laurel Ave., Bridgeport, Conn.

WITHINGTON, Sidney (Junior, 1908), Walworth Mfg. Co., South Boston, and *for mail*, 35 Bay State Rd., Boston, Mass.

DEATHS

JENNINGS, Edward L.

COMING MEETINGS

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Week of December 28, annual meeting at Johns Hopkins University, Baltimore, Md. Secy., L. O. Howard, Washington, D. C.

AMERICAN GEOGRAPHICAL SOCIETY

December 22, 29 W. 39th St., New York, 8 p.m. Paper: Geography of Japan, Wm. Eliot Griffis. Acting Secy., Geo. C. Hurlbut, 15 W. 81st St., New York.

AMERICAN INSTITUTE OF ARCHITECTS

December 15–17, annual convention, Washington, D. C. Secy., Glenn Brown, the Octagon.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

December 11, Jan. 8, 1909, 33 W. 39th St., New York, 8 p. m. Secy., R. W. Pope.

AMERICAN SOCIETY OF CIVIL ENGINEERS

December 16, New York. Secy., Chas. W. Hunt, 220 W. 57th St.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

January 12, 1909, monthly meeting, 29 W. 39th St., New York, 8 p.m. Secy., Calvin W. Rice.

BLUE ROOM ENGINEERING SOCIETY

January 5, monthly meeting, 29 W. 39th St., New York, 8 p.m. Secy., W. D. Sprague, 100 N. Moore St.

BOSTON SOCIETY OF CIVIL ENGINEERS

December 16, monthly meeting, Tremont Temple. Secy., S. E. Tinkham, 60 City Hall.

CANADIAN RAILWAY CLUB

January 5, 1909, Montreal, Que. Secy., Jas. Powell, Grand Trunk Ry.

CANADIAN SOCIETY OF CIVIL ENGINEERS

December 10, business meeting, December 17, mining section; January 7, 1909, general section meeting; 413 Dorchester St. W., Montreal, Que. Secy., Prof. C. H. McLeod.

CAR FOREMEN'S ASSOCIATION OF CHICAGO

December 14. Secy., Aaron Kline, 326 N. 50th St.

CENTRAL ASSOCIATION OF RAILROAD OFFICERS

January 1, 1909, annual meeting, 257 Broadway, Indianapolis, Ind. Secy., G. B. Staats, Care of Penna. Lines.

CENTRAL ASSOCIATION OF RAILROAD OFFICERS

December 14, Kansas City. Secy., J. H. Ashley, Gumbel Bldg.

CENTRAL ASSOCIATION OF RAILROAD OFFICERS

December 10, Toledo, O. Secy., H. M. Elliott.

CENTRAL RAILWAY AND ENGINEERING CLUB OF CANADA

December 15, Rossin House, Toronto, Ont. Secy., C. L. Worth, Room 409, Union Station.

CENTRAL RAILWAY CLUB

January 8, 1909, Buffalo, N. Y., 2 p.m. Secy., H. D. Vought, 95 Liberty St., New York.

COLORADO SCIENTIFIC SOCIETY

December 19, annual meeting, Denver. Secy., Dr. W. A. Johnston, 801 Symes Bldg.

ENGINEERING ASSOCIATION OF THE SOUTH

December 15, monthly meeting, Nashville Section, Carnegie Library Bldg. Section Secy., H. H. Trabue, Berry Block, Nashville.

ENGINEERING SOCIETY OF THE STATE UNIVERSITY OF IOWA

January 5, 1909, monthly meeting, Iowa City. Dean, Wm. G. Raymond.

ENGINEERS' CLUB OF BALTIMORE

January 2, 1909, monthly meeting. Secy., R. K. Compton, City Hall.

ENGINEERS' CLUB OF CENTRAL PENNSYLVANIA

January 5, 1909, annual meeting, Gilbert Bldg., Harrisburg. Secy., E. R. Dasher.

ENGINEERS' CLUB OF CINCINNATI

December 17, 25 E. 8th St. Secy., E. A. Gast, P. O. Box, 333.

EXPLORERS' CLUB

January 1, monthly meeting, 29 W. 39th St., New York, 8.30 p.m. Secy., H. C. Walsh.

GENERAL SUPERINTENDENTS' ASSOCIATION

December 16, Chicago, Ill. Secy., H. D. Judson, C. B. & Q. R. R., Chicago.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS

January, 1909, annual meeting at Chicago. Secy. E. E. R. Tratman, 1636 Monadnock Blk.

ILLUMINATING ENGINEERING SOCIETY

December 10, monthly meeting, New York Section, 29 W. 39th St., 8 p.m. Secy., P. S. Millar.

INDIANA ENGINEERING SOCIETY

January 14-16, 1909, Commercial Club. Secy., Chas. Brossmann, 43 Union Trust Bldg., Indianapolis.

IOWA RAILWAY CLUB

December 11, Des Moines. Secy., W. B. Harrison, Union Sta.

LOUISIANA ENGINEERING SOCIETY

December 14, monthly meeting, 323 Hibernian Bldg., New Orleans. January 9, 1909, annual meeting, New Orleans. Secy., L. C. Datz, 323 Hibernian Bldg.

MICHIGAN ENGINEERING SOCIETY

January, 1909, Ann Arbor. Secy., Alba L. Holmes, Grand Rapids,

MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK

December 23, 29 W. 39th St., 8:15 p.m. Secy., C. D. Pollock.

NEW ENGLAND RAILROAD CLUB

December 8, Boston. Paper: The Railroad Man in Politics, Wm. F. Garcelon. Secy., Geo. H. Frazier.

NEW ENGLAND STREET RAILWAY CLUB

December 24, American House, Boston, Mass. March 25, 1909, annual meeting. Secy., John J. Lane, 12 Pearl St.

NEW YORK RAILROAD CLUB

December 18, 29 W. 39th St. Secy., H. D. Vought, 95 Liberty St.

NEW YORK SOCIETY OF ACCOUNTANTS AND BOOKKEEPERS
December 15, 22, January 5, 1909, 29 W. 39th St., 8 p.m. Secy., T. L. Woolhouse.

NEW YORK TELEPHONE SOCIETY
December 15, 29 W. 39th St., 8 p.m. Secy., T. H. Laurence, 63 Irving Pl., New York.

NORTHERN RAILWAY CLUB
December 26, Commercial Club Rooms, Duluth, Minn. Secy., C. L. Kennedy.

NORTH WEST RAILWAY CLUB
December 15, Minneapolis, Minn. Secy., T. W. Flannagan, Soo Line, Minneapolis.

PROVIDENCE ASSOCIATION OF MECHANICAL ENGINEERS
December 22, monthly meeting, 48 Snow St. June 22, 1909, annual meeting. Secy., T. M. Phetteplace.

PURDUE MECHANICAL ENGINEERING SOCIETY
December 23, January 6, 1909, fortnightly meetings, Purdue University, Lafayette, Ind., 6:30 p.m. Secy., L. B. Miller.

RAILWAY CLUB OF PITTSBURGH
December 25, monthly meeting, Monongahela House, Pittsburg, Pa., 8 p.m. Secy., J. D. Conway, Gen. Office, P. & L. E. R. R.

RENSSELAER SOCIETY OF ENGINEERS
December 18, 257 Broadway, Troy, N. Y. Secy., R. S. Furber.

RICHMOND RAILROAD CLUB
December 14. Secy., F. O. Robinson, C. & O. Railway.

ROCHESTER ENGINEERING SOCIETY
December 11, January 8, 1909, monthly meetings. Secy., John F. Skinner, 54 City Hall.

ST. LOUIS RAILWAY CLUB
December 11, monthly meeting. Secy., B. W. Frauenthal.

SCRANTON ENGINEERS' CLUB
December 17, Board of Trade Building. Secy., A. B. Dunning.

TECHNICAL SOCIETY OF BROOKLYN
December 18, January 1, 1909, bi-monthly meetings, Arion Hall, Arion Place, Brooklyn, N. Y., 8:30 p.m. Paper for December: New York Laws on Tenement House Construction. Secy., Karl Koelble.

WASHINGTON SOCIETY OF ENGINEERS
December 15, Hubbard Memorial Hall, 8 p.m. Secy., John F. Hoyt, 1330 F. St. N. W. Paper: Utility of the Water Resources of the Hawaiian Islands, F. H. Newell.

WESTERN RAILROAD ASSOCIATION
January, 1909, annual meeting. Secy., Edw. P. Amory, 1330 Marquette Bldg., Chicago, Ill.

WESTERN RAILWAY CLUB
December 15, monthly meeting, Auditorium Hotel, Chicago, Ill., 8 p.m. Secy., Jos. W. Taylor, 390 Old Colony Bldg.

WESTERN SOCIETY OF ENGINEERS
December 11, electrical section, December 16, extra meeting; 1737 Monadnock Blk., Chicago, Ill. January 5, 1909, annual meeting. Secy., J. H. Warder.

OFFICERS AND COUNCIL

1908

PRESIDENT

M. L. Holman .... St. Louis, Mo.

VICE-PRESIDENTS

Alex Dow .... Detroit, Mich.
P. W. Gates .... Chicago, Ill.
J. W. Lieb, Jr .... New York

Terms expire at Annual Meeting of 1908

L. P. Breckenridge .... Urbana, Ill.
Fred J. Miller .... Center Bridge, Pa.
Arthur West .... E. Pittsburg, Pa.

Terms expire at Annual Meeting of 1909

PAST PRESIDENTS

James M. Dodge .... Philadelphia, Pa.
Ambrose Swasey .... Cleveland, O.
John R. Freeman .... Providence, R. I.
Frederick W. Taylor .... Philadelphia, Pa.
F. R. Hutton .... New York

Members of the Council for 1908

MANAGERS

Walter Laidlaw .... Cincinnati, O.
Frederick M. Prescott .... Milwaukee, Wis.
Frank G. Tallman .... Wilmington, Del.

Terms expire at Annual Meeting of 1908

G. M. Basford .... New York
A. J. Caldwell .... Newburg, N. Y.
A. L. Riker .... Bridgeport, Conn.

Terms expire at Annual Meeting of 1909

Wm. L. Abbott .... Chicago, Ill.
Alex. C. Humphreys .... New York
Henry G. Stott .... New Rochelle, N. Y.

Terms expire at Annual Meeting of 1910

TREASURER

William H. Wiley .... New York

HONORARY SECRETARY

F. R. Hutton .... New York

CHAIRMAN OF FINANCE COMMITTEE

A W. Burchard .... Schenectady, N. Y.

SECRETARY

Calvin W. Rice .... 29 W. 39th Street, New York, N. Y.

STANDING COMMITTEES

1908

FINANCE

Anson W. Burchard (1), *Chairman*
Arthur M. Waitt (2)
Edward F. Schnuck (3)
J. Waldo Smith (4)
A. C. Dinkey (5)

MEETINGS

Chas. Whiting Baker (1), *Chairman*
W. E. Hall (2)
Wm. H. Bryan (3)
L. R. Pomeroy (4)
Charles E. Lucke (5)

MEMBERSHIP

Jesse M. Smith (1), *Chairman*
Henry D. Hibbard (2)
Charles E. Richards (3)
Francis H. Stillman (4)
George J. Foran (5)

PUBLICATION

Fred J. Miller (1)
Walter B. Snow (2)
D. S. Jacobus (3)
H. F. J. Porter (4)
H. W. Spangler (5)

LIBRARY

A. W. Howe (1)
H. H. Suplee (2), *Chairman*
Ambrose Swasey (3)
Leonard Waldo (4)
G. M. Basford (5)

EXECUTIVE

M. L. Holman
F. W. Taylor
J. W. Lieb, Jr.
Fred J. Miller
Calvin W. Rice

Note—Numbers in parentheses indicate length of term in years that member is yet to serve.

SPECIAL COMMITTEES

1908

On a Standard Tonnage Basis for Refrigeration

D. S. Jacobus
A. P. Trautwein
G. T. Voorhees
Philip De C. Ball
E. F. Miller

On Society History

John E. Sweet
H. H. Suplee
Charles Wallace Hunt

On Affiliated Societies

F. R. Hutton, *Chairman*
R. H. Fernald
F. W. Taylor
H. H. Suplee
Alex. C. Humphreys

On By-Laws for Research Committee

Chas. Wallace Hunt, *Chairman*
G. M. Basford
F. R. Hutton
D. S. Jacobus
Jesse M. Smith

On Increase of Membership

William C. Dickerman, *Chairman*
George J. Foran
Charles E. Lucke
Frederick M. Whyte

On Conservation of Natural Resources

Geo. F. Swain, *Chairman*
M. L. Holman
L. D. Burlingame
Calvin W. Rice
Charles Whiting Baker

On International Standard for Pipe Threads

E. M. Herr, *Chairman*
Stanley G. Flagg, Jr.
Geo. M. Bond
William J. Baldwin

On Thurston Memorial

Alex. C. Humphreys, *Chairman*
Fred J. Miller
Charles Wallace Hunt
J. W. Lieb, Jr.

SOCIETY REPRESENTATIVES

1908

On John Fritz Medal

John E. Sweet
Henry R. Towne
Ambrose Swasey
F. R. Hutton

On Union Engineering Building

James M. Dodge (1)
Chas. Wallace Hunt (2)
F. R. Hutton (3)

Joint Library Committee

H. H. Suplee, *Chairman for Am.Soc.M.E.*

On National Fire Protection Association

John R. Freeman
Ira H. Woolson

On Hudson-Fulton Celebration

Geo. W. Melville
M. L. Holman

On Promotion of Engineering Education

Alex. C. Humphreys
F. W. Taylor

On Government Advisory Board on Fuels and Structural Materials

P. W. Gates
W. F. M. Goss
Geo. H. Barrus

On Council of American Association for the Advancement of Science

Alex. C. Humphreys
Fred J. Miller

OFFICERS OF THE GAS POWER SECTION
1908

PRESIDENT

Dr. Charles E. Lucke

SECRETARY

Henry Harrison Suplee

EXECUTIVE COMMITTEE

Prof. R. H. Fernald, *Chairman*
F. R. Low
G. I. Rockwood
F. H. Stillman
H. H. Suplee

MEMBERSHIP COMMITTEE

Robert T. Lozier, *Chairman*
D. B. Rushmore
F. S. King
George A. Orrok
George W. Whyte
Albert A. Cary
Joseph E. Aue
T. W. Snow

MEETINGS COMMITTEE

Henry L. Doherty, *Chairman*
M. N. Latta
Chas. E. Sargent
F. P. Thorp
E. P. Coleman
C. L. Straub
W. T. Magruder
Arthur L. Rice

THE JOURNAL

OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

VOL. 30 SEPTEMBER 1908 NUMBER 7

THE first monthly meeting of the Society will be held in the Engineering Societies Building on the evening of October 13. The meeting will be conducted by the Gas Power Section and the communications presented at Detroit in regard to standardization, which are published in this number of The Journal, will be brought up for discussion. The papers to be read at this meeting will be published in The Journal of October 1.

ANNUAL MEETING

The annual meeting of the Society will be held in New York, December 1–4, inclusive, and as the time of the meeting is earlier than usual, members intending to submit papers are urgently requested to forward them at the earliest possible date. Manuscript upon technical subjects requires careful preparation for publication and in order to be satisfactory alike to authors and to the readers of The Journal ample time must also be taken for its mechanical production as well.

The important feature of the December meeting will be a symposium upon Machine Shop Practice, following naturally the session upon Foundry Practice of a year ago. Fifteen hundred members of the Society are intimately associated with plants engaged in the design and construction of machinery. It is essential to progress that every member keep informed upon new developments in machine shop methods. The discussions at this session in December will be varied

and unusually important, and no member who can arrange to attend the meeting can afford to miss them.

REGULAR MEETING OF THE COUNCIL

June 23, 1908, in the office of the vice-president of the Society, Mr. Alex. Dow, Detroit, Mich.

President M. L. Holman, presiding; and present also Messrs. Swasey, Lieb, Dodge, Breckenridge, Hutton, Gates, West, Hunt, Dow and the Secretary.

Members deceased are as follows:

Gustav Herrmann, Honorary Member

F. C. Warman	Ferdinand Phillips
F. N. Fowler	S. B. Cox
Fredk. A. Johnson	Joseph Stone
E. F. Schaefer	H. W. Cake

The following resignations were reported, the members having complied with the rules:

W. L. Hedenberg	Jno. W. Loveland
F. G. Kretschmer	M. T. Conklin

Under the provisions of C 24 of the Constitution, the following names were withdrawn from the roll of membership:

G. L. Backstrom	Geo. H. Lilley
J. M. Barnay	J. H. Pitkin
C. E. Bement	Wm. M. Power
Frank G. Brown, Jr.	C. Reeves
Wm. L. Chase	W. C. Swift
W. Lemuel Clark	H. Van Atta
J. R. Caldwell	Jos. D. Wallace
Donald Enock	John Dick
Jno. B. Fleming	P. P. Rooney
H. deF. Hubbard	J. C. Knight
Walter Kirton	Jos. Kuhn
Camille A. Lamy	

Professor Hutton, the Honorary Secretary, reported the transfer from his account as treasurer, of $788.32 of the Robert H. Thurston Memorial Fund, to the treasurer of the Society. It was thereupon moved and carried:

That the Council of the Society receive the $788.32 and that it be held as the Robert H. Thurston Memorial Fund.

Library: The Chairman of the Library Committee reported in person the provisional action of the chairmen of the library committees of the Founder Societies, and the Council thereupon adopted the following resolutions:

First: That the administration of the library be placed in the hands of the chief librarian, all employees of the library to be subject to the direction of the said chief librarian. It was agreed that Miss. L. E. Howard should be appointed chief librarian.

Second: That each new employee in the library shall be approved both by the authorized representative of the Founder Societies interested, and by the chief librarian.

Third: In the event of any employee not being satisfactory to said representative of the Founder Societies interested, or to the chief librarian, the fact shall be reported by the chief librarian to the House Committee, which shall have the power to act.

Fourth: That in the absence of the chief librarian, the House Committee shall have the right to specify an employee of the library to act as chief librarian, during such period of absence.

Fifth: That the United Engineering Society be requested to pay the salaries of all the library employees, and the amount to be repaid by the Founder Societies respectively shall be distributed in such proportion as may be jointly agreed upon.

Finance: A provision was made for opening an account of the Society in the Bank of the Metropolis, New York.

Resolutions were also passed authorizing and directing the President of the Society to sign such checks as may be required in emergency, using the signature of acting treasurer of the Society.

New business: the first reading of a proposed amendment to By-Laws 44 and 45 relative to standards for the conduct of the business affairs of the Society approved.

The meeting then declared adjourned to Friday, June 26.

ADJOURNED COUNCIL MEETING

June 26, 1908, adjourned meeting. President M. L. Holman presiding and present, also, Messrs. Gates, Lieb, Breckenridge, Swasey, Hutton and the Secretary.

The Council passed the following motions with respect to matters which had been referred to them by the meeting of the Society just adjourned:

Voted: That the Gas Power Section be requested to nominate a committee of five to revise the code for conducting gas engine tests, and prepare a code for testing of gas producers.

Voted: That the president appoint a committee of five to take up modifications of the report on Standard Proportions of Machine Screws.

Voted: That the president refer to a committee of three of the Council, the matter of standard color scheme for piping in power stations.

The following was also voted by the Council:

That the Secretary be instructed to invite the past-presidents to attend the meetings of the Council.

Adjournment.

THE SPRING MEETING AT DETROIT

The 57th meeting of the Society was held at Detroit, June 23 to 26, with an attendance of 717. On Tuesday evening, June 23, was an informal reception, with an address of welcome by Mayor Thompson of Detroit, and a response by President Holman. Mayor Thompson expressed his pride in the professional accomplishments of the local members of the Society, and welcomed the visiting members as representatives of a profession engaged in lightening men's work and in making it possible for an ordinary man to enjoy some of the luxuries and comforts of life. In his response President Holman referred to the industrial undertakings of the city, to its many attractions, and voiced the pleasure of the visiting members and their friends with the hearty welcome extended.

BUSINESS MEETING

On Wednesday morning, June 24, was the business meeting and first professional session. President Holman called the meeting to order and read the report of the tellers of election announcing the candidates elected to membership in the Society. The list is published, with other lists relating to membership, at the end of the reading pages of this number.

The Secretary announced as follows the committee appointed by the president to nominate officers for the ensuing year: Mr. James M. Dodge, Philadelphia, chairman; Mr. George H. Barrus, Boston; Mr. Fred M. Prescott, Milwaukee; Mr. Frank E. Shepard, Denver; and Mr. Newell Sanders, Chattanooga.

In making this announcement he called attention to the fact that the President in his administration had particularly recognized the national character of the organization and in choosing committees had selected members of the Society from widely different parts of the country.

The Secretary welcomed to the professional and social events of the Society the members of the other societies in convention at Detroit at that time, the Society for the Promotion of Engineering Education,

the Society of Automobile Engineers and the American Gas Power Society. On the other hand announcement was made of meetings and papers of the other societies which would interest the members of the Society.

This concluded the regular business, and under the order of new business, Professor Hutton, honorary secretary, made a motion providing for the revision of the report on standard methods for conducting tests of gas engines. Great credit has come to the Society from the preparation of special reports covering methods of conducting engineering research work. One of the most creditable of these is that relating to gas engine tests, but as it is now about three years old, and there has been rapid development of the internal combustion engine, the report is in need of revision. He therefore moved that the Council be requested to ask the Gas Power Section of the Society to make recommendations for the revision of the Society's code for making tests of internal combustion engines.

The motion, seconded by Dr. R. C. Carpenter, was carried.

Mr. Frank Sutton explained that one of the reasons for urging the revision of this code is the fact that it would be desired by authors to incorporate it in books to be published, and he urged that the revision be made at as early a date as possible.

The president suggested that while revising the standards for conducting tests on gas engines, it would be desirable to revise the standards for testing all engines, placing all upon the heat unit basis, which was the only proper basis for a duty test of an engine, or for engine guaranty.

SYMPOSIUM ON CONVEYING OF MATERIALS

This concluded the new business, and the balance of the session was devoted to a symposium upon the hoisting and conveying of materials. The five papers scheduled upon this subject were presented in succession and a long discussion followed the reading of the last paper. These papers were as follows:

a Hoisting and Conveying Machinery, by George E. Titcomb, Philadelphia, published in June Proceedings. This paper describes present day facilities in the mechanical transfer of materials, especially coal and ore, dealing with the intermittent class of raw material conveyors, including open air and covered coal storage apparatus, traversing and revolving bridge tramways, locomotive cranes, hoisting towers, etc.

b The Continuous Conveying of Materials, by Staunton B. Peck, published in June Proceedings. The paper covers only the conveying of materials by continuous machines, and describes some of the types in use, giving data as to their adaptabilities, capacities, power consumed and economies effected. Following this applications of conveying machinery are shown with some figures relating to capacities and economy.

c The Belt Conveyor by C. Kemble Baldwin, published in June Proceedings. The author outlines the possibilities of the belt conveyor for handling heavy abrasive materials, and gives data for aid in the preparation of designs. He makes several claims for this type of conveyor, which his experience has shown to be well founded, holding that local conditions have an important influence on the choice of the proper width and character of belt, general arrangement, etc., and that on these matters the specialist should be consulted in order to get the best results.

d Conveying Machinery in a Portland Cement Plant, by C. J. Tomlinson, published in June Proceedings. Conditions in cement plants are such as to test conveying apparatus to its utmost, and indicate that heavier and more simple devices should be adopted, with convenient means of recording the performances of the machinery served. The author recommends devices similar to the blast furnace, skip hoist and scale transfer car.

e The Performance of Belt Conveyors, by E. J. Haddock, published in this number of The Journal. The results of tests upon belt conveyors are reported in this paper with conclusions and formulas bearing upon the design and operation of this type of apparatus.

The discussion at this session is published in full in this number of The Journal, and the following is a list of those participating: Messrs. Spencer Miller, Melvin Pattison, Geo. B. Willcox, Charles Piez, E. H. Messiter, T. A. Bennett, Jas. M. Dodge, R. C. Carpenter, E. S. Fickes, Edw. G. Thomas, H. W. Hibbard, John McGeorge, W. T. Donnelly, H. H. Suplee, Wm. Kent and A. B. Proal.

The closures upon these discussions by the several authors as well as upon the other discussions in this number will appear in a later issue of The Journal.

THIRD SESSION

The afternoon session began with a paper by Prof. R. C. H. Heck, on Thermal Properties of Superheated Steam, published in May Pro-

ceedings, in which a graphical comparison is made of data from experiments of Knoblauch and Jakob and of Thomas upon specific heat of superheated steam under constant pressure. This shows a marked difference near the point of saturation, accounted for by the author in part by errors in interpretation by Knoblauch and Jakob. A new interpretation is made of the results of the two later investigators, bringing them into essential agreement with the work of Thomas. There is a table giving specific heat and other data relating to superheated steam.

Professor Heck's paper was read for the author by Prof. L. P. Breckenridge, and drew out an extended discussion by Prof. H. T. Eddy, of the University of Minnesota; contributed discussions by Dr. Harvey N. Davis, of Harvard University, and Prof. W. D. Ennis; and an oral discussion by Mr. Henry Harrison Suplee.

The second paper was on A Rational Method of Checking Conical Pistons for Stress, by Prof. George H. Shepard, published in February Proceedings. In the absence of the author it was presented by Mr. George A. Orrok. It leads to the deduction of formulas for stress derived by methods intended to be applicable to a conical piston of any form. A contributed discussion was offered by Mr. M. Nusim.

The concluding paper was upon A Journal Friction Measuring Machine, by Mr. Henry Hess, published in January Proceedings. It describes a machine in which journals can be subjected to radial loads, thrust loads, or both simultaneously, and at varied speeds. The sensitiveness of the machine is sufficient to permit an analysis of bearing friction that will show the influence of the slight sliding friction always present in bearings, besides rolling friction. Diagrams are shown indicating the relation of load and friction in radial ball bearings and in thrust ball bearings, of the speed and load in equal thrust ball bearings, and of the effect on the friction of the more usual forms of ill treatment. In the absence of the author the paper was presented by Dr. C. H. Benjamin, who also contributed a discussion. It was further discussed by Mr. J. Royden Peirce, New York, and Dr. John A. Brashear.

LECTURE

On Wednesday evening was the delightful lecture by Dr. John A. Brashear, on Contributions of Photography to Our Knowledge of Stellar Evolution. To many this was the crowning event of the several meetings. The lecture was given in the hall of the Y. M. C. A. before a large audience, which the speaker had at his command until his last

word was spoken. Many photographs were thrown on the screen, beginning with views of astronomical apparatus, and following with views of constellations, the moon and the planets; and of greater beauty than all, photographs of nebulæ, the existence of which had never been suspected until detected by the photographic plate.

FOURTH SESSION

The session on Thursday afternoon, June 25, opened with a paper on The Surge Tank in Water Power Plants, by Mr. Raymond D. Johnson, published in June Proceedings. The paper deals with the momentum of flowing water in long pressure pipes for the supply of hydraulic turbines for impulse wheels, and of the control of rate of flow for the speed regulation of water wheels without harmful results or waste of water through relative values or deflecting nozzles or by-passing it. This is accomplished by a surge tank near the down stream end of the pressure pipe, which may be either under atmospheric pressure simply, or under compressed air. The paper treats the subject mathematically, and gives formulas for proportioning the sizes of surge tanks under various conditions, besides treating of a novel device called by the author a differential regulator, by which the diameter of the tank may be reduced, thereby lessening its cost. This paper was discussed at length by Mr. L. F. Harza, Madison, Wis., Prof. Irving P. Church, of Cornell University, Mr. Morris Knowles, and Mr. Chester W. Larner. The discussion will be published complete in the October 1 number of The Journal.

Some Pitot Tube Studies, by Prof. W. B. Gregory and Prof. E. W. Schoder, published in May Proceedings, considers the distribution of velocities and pressures of flowing water as determined by experiment in straight and curved portions of a pipe, by the aid of the Pitot tube. A study is made of the indications of a Pitot tube, both with the impact opening facing the current and the reverse, and there is given a convenient method for making Pitot tube traverses in straight pipe. It was discussed by Mr. George A. Orrok, Prof. H. T. Eddy, of the University of Minnesota, and Dr. Sanford A. Moss.

A brief paper, A Comparison of Screw Thread Standards, was contributed by Mr. Amasa Trowbridge, published in June Proceedings. It contains a diagram showing to what extent present recognized standards for screw threads harmonize or may be combined. The paper was read by Mr. L. D. Burlingame, who also contributed a discussion proposing formulas for a standard fine pitch screw system, forming a

connecting link between machine screw sizes and United States standard threads used on the larger sizes of bolts. The paper was further discussed by Mr. F. A. Halsey, who contended that a standard for fine pitch screws was desirable and moved that a committee be appointed to investigate the subject. The motion was carried.

The next paper in order was on The Identification of Power House Piping by Colors, by Mr. William H. Bryan, published in June Proceedings. It advocates the adoption of a system for coloring pipe lines; with further subdivision, if required, by giving the flanges a different tint, by means of which the different pipe lines in modern power plants may be distinguished and confusion avoided. The author presents schemes for coloring pipe lines of any size and believes the time is ripe for the establishment of a uniform standard.

The discussion was by Mr. George E. Mitchell, Mr. Frederick W. Salmon, Mr. John W. Lieb, Jr., and Mr. George A. Mattsson. At the close of his discussion Mr. Lieb offered a motion, seconded by Mr. L. D. Burlingame, that the suggestions made in the paper as to the formulation of a code of symbols for power house piping be referred to the Council of the Society for consideration. The motion was carried.

The discussions upon the last three papers of this session is given elsewhere in this number.

GAS POWER SESSION

A session of the Gas Power Section of the Society was held simultaneously on Thursday afternoon. Dr. Charles E. Lucke, president of the Section, presided.

The first business was the reports of the standing committees. The secretary of the Section, Mr. Suplee, presented a progress report for Mr. Henry L. Doherty, chairman of the Section Meetings Committee, stating that papers were in hand for a meeting in New York in October.

The secretary also presented a report for Mr. Robert T. Lozier, chairman of the Section Membership Committee, calling attention to the fact that registration is necessary for members of the Society to be enrolled as members of the Section, and also urging all others interested in the subject of gas power who have not joined the Section to enroll as affiliates.

The Section Committee on Standardization made a progress report, including extended communications from Mr. J. R. Bibbins, Mr. H. F.

Smith and Mr. Arthur West, members of the committee, together with a communication from Mr. J. B. Klumpp, a member of the Gas Engine Committee of the National Electric Light Association. This progress report contained material of great value and is given complete in this number of The Journal.

The secretary reported the action at the business meeting of the Society to the effect that the revision of the Society code for testing gas engines had been referred to the Council, with suggestions that its revision be placed in the hands of the Gas Power Section.

GAS POWER PAPERS

The Section then proceeded to the discussion of professional papers as follows:

The By-Product Coke Oven, by Mr. W. H. Blauvelt, published in March Proceedings. This paper discusses the advantageous production of coke in retort ovens for the purpose of securing the valuable chemical by-products. Its principal interest to the Section lies in the discussion of the production of power gas in connection with the coking operation, and the paper contains tabulated data of the yields and character of the gas produced from various coals and the application for use in gas engines.

The discussion upon this paper, published in this number, was by Messrs. J. R. Bibbins, C. M. Barber, C. G. Atwater, Prof. R. H. Fernald and Messrs. J. C. Parker and G. J. Rathbun.

The next paper was upon Power Plant Operation on Producer Gas, by Mr. G. M. S. Tait, published in June Proceedings.

Mr. Tait's paper refers especially to the desirability of using a producer gas containing little or no hydrogen, the combustible consisting almost entirely of carbon monoxide. The producer described by Mr. Tait dispenses entirely with steam or moisture in the blast and utilizes a portion of the exhaust gases of the engine supply below the grate to dilute the air and regulate the combustion.

This paper was discussed by Messrs. C. W. Lummis, H. F. Smith, E. P. Coleman, C. J. Davidson, H. W. Peck, F. H. Stillman, H. W. Jones and J. R. Bibbins, the discussion being published in this number.

The next paper was upon Horse Power, Friction Losses and Efficiencies of Gas and Oil Engines, by Prof. Lionel S. Marks.

This paper is principally a discussion of the question as to whether the power required to operate compression pumps and other auxiliary parts of the engine should be deducted in computing the indicated

horse power. Reference was made to the extent of the discussion on this subject three years ago in the Society of German Engineers, and it was agreed that the whole matter should properly come before the Standardization Committee for consideration. The secretary was requested to prepare an abstract of the German discussion for the use of the members and of the Standardization Committee. This has been done and the abstract is given in this number.

The last paper was upon A Simple Method of Cleaning Gas Conduits, by W. D. Mount.

RECEPTION

On Thursday evening was a reception, with dancing and refreshments at the Hotel Cadillac.

CONCLUDING SESSION

The last session was on Friday morning, June 26, and the first paper was upon Economy Tests of High Speed Engines, by Mr. F. W. Dean and Mr. A. C. Wood, published in June Proceedings. It reviews tests upon eight high speed engines, which had been in use a considerable length of time. The object of the tests was to determine the steam per indicated horse power per hour and per kilowatt hour, and also the efficiency of the generating sets as shown by the ratio of the indicated horse power to the electrical horse power at the switch board. The engines were not put in order for the tests. There was a long discussion on this paper by the following: Messrs. Geo. H. Barrus, C. A. Dawley, Richard H. Rice, R. C. Stevens; Mr. John R. Parker, non-member, Rochester, New York, Dr. W. F. M. Goss, and Messrs. F. A. Halsey and C. H. Treat.

The second paper, upon Air Leakage in Steam Condensers, by Mr. Thomas C. McBride, published in June Proceedings, advocates measuring by air pump displacement and temperature the amount of air passing through a condenser, and comparing this amount in different condensers on the basis of its ratio by volume to the steam being condensed. The paper recommends that in testing condensers engineers measure the amount of air on the basis suggested, in order that the amount of air anticipated by ordinary practice may be established. Tests are cited showing widely different air leakages under different conditions. Discussions upon the paper were by Mr. Charles A. Howard and Mr. C. L. Heisler.

The concluding paper on Clutches, by Mr. Henry Souther, had been presented previously at the New York Monthly Meeting held in May. The discussion was continued at the Detroit Meeting, and at the invitation of the Society members of the Society of Automobile Engineers participated in the proceedings. It is proposed to publish the complete discussion upon this paper in October.

This concluded the professional papers, and resolutions were then offered by Mr. C. W. Hunt, and seconded by Mr. Charles Whiting Baker, extending the thanks of the Society to the members of the local committee and others who had provided so enjoyable a time for the visiting members. The resolutions were as follows:

WHEREAS, The American Society of Mechanical Engineers in convention assembled at Detroit, June 26, 1908, desires to express its appreciation of the many hospitalities extended to its visiting members and friends by its hosts, the local members and their friends of Detroit; and to all who, by untiring efforts, have made the Spring Meeting of 1908 so extraordinarily pleasant, and so profitable an occasion.

Be it Resolved, That the secretary be instructed to extend the thanks of the Society and to express the deep appreciation of its members and guests to the chairman and members of the local committee and especially to the ladies of the local committee for the splendid entertainment provided; to the Great Lakes Engineering Works and its president, Mr. A. C. Pessano, for the arrangements connected with the launching; to Mr. F. E. Kirby and the engineering staff of the Detroit Tunnel; to the Detroit, Belle Isle and Windsor Ferry Company for the use of an excursion steamer; to the several manufacturing plants of the city, so freely opened for inspection; and, to Prof. J. A. Brashear for his lecture, which afforded so delightful an evening's entertainment.

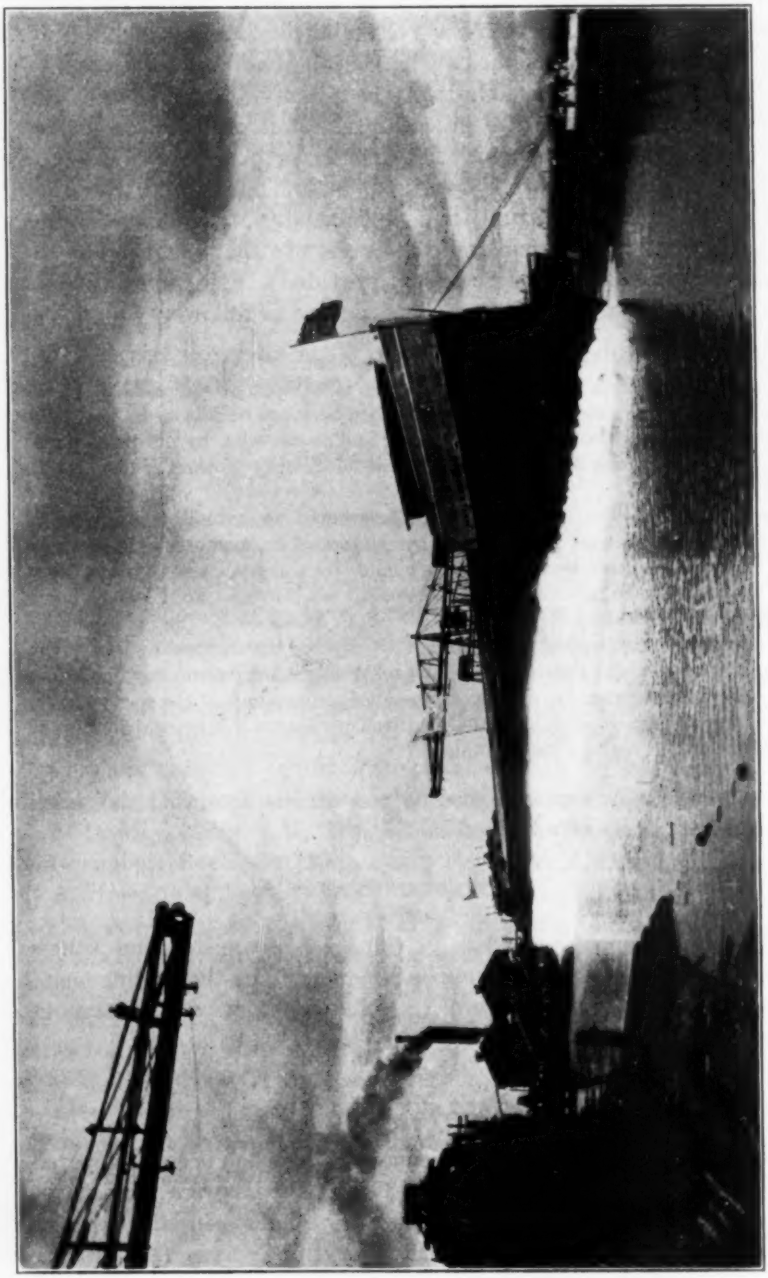
These resolutions were passed by unanimous vote, and the meeting was then declared adjourned.

ENTERTAINMENT

The entertainment provided by the local committee and others interested in the Society will long be remembered by the visiting members and their guests because of the solid enjoyment and continuous round of pleasures which it afforded.

THE LAUNCHING

The launching of the Daniel B. Meacham, which had been anticipated so much, was a beautiful sight. The members were carried by steamer to Ecorse and when the boat drew up alongside the docks of the Great Lakes Engineering Works everything was in readiness for



Launch of the Daniel B. Meacham

the launching. The army of men stationed beneath the hull of the Meacham to drive in the wedges and raise the boat so she would be supported on the shoes which were to carry her down the ways, promptly began their work. The blows in rapid succession sounded like a battery of machine guns. As is the practice on the Great Lakes, the boat was launched sidewise into a slip, by this means avoiding possible obstruction to the channel where the freight traffic is so heavy. When at last the eight cables holding in place the eight timber triggers which retained the boat at the top of the ways were severed simultaneously by eight axemen, the hull slid gracefully into the water.

The launching was arranged to occur at the time of this meeting through the untiring efforts of Mr. Antonio C. Pessano, member of the Detroit local committee, and president and general manager of the Great Lakes Engineering Works. The date of the launching had been advanced two weeks in order to have it occur at the time of the meeting, which had necessitated night and day work to make everything in readiness.

It was the 49th launching at the Great Lakes Engineering Works and Mr. Pessano pronouned it the best one of them all.

On the return from the launching a view was had of a section of the Detroit tunnel as it lay near the shore, preparatory to sinking it to the bed of the river.

OTHER SOCIAL FEATURES

The excursion on Friday afternoon on the steamer Britannia, tendered by the Detroit, Belle Isle and Windsor Ferry Company, through Mr. F. E. Kirby, member of the Detroit local committee, was the important social event and consisted of a sail to and from Bois Blanc Island, with a fine dinner on the island at the Casino. The real benefits to be secured from a convention were most completely secured on this delightful trip, where each member had an opportunity to exchange experiences with others.

The local ladies in charge of entertainment for the visiting ladies had something in store for every moment. A luncheon with a most tempting menu was served at Belle Isle Park and the visitors were entertained at the country club, by automobile trips and in other ways. The enthusiasm of the ladies over the cordial reception which they received was so great that special resolutions were passed by them expressing their appreciation, in addition to those passed by the Society itself at the final session. A measure of the success of this

meeting was the large attendance of ladies, about 80 being present, which is the largest number at any meeting away from New York.

Much interest was shown by the members in the various manufacturing plants of the city, and particularly the automobile plants, which many took occasion to visit.

Meetings of Other Societies at Detroit

Other societies meeting at Detroit simultaneously with The American Society of Mechanical Engineers were the Society for the Promotion of Engineering Education, the Society of Automobile Engineers, and the American Gas Power Society. Members attending the meetings of these were invited to become the guests of the A.S.M.E. at their meetings and to participate in the entertainment provided by the local committee of the Society.

The meetings of the Society for the Promotion of Engineering Education were well attended, particularly by those interested in the teaching of mechanical engineering. The report of the secretary, Prof. Arthur L. Williston, showed the membership to be increasing rapidly. Many papers were presented, offering suggestions for changes and possible improvements in courses of instruction. One of these was an interesting proposal by Mr. Harwood Frost, New York, for a general course in engineering, teaching the fundamental principles of civil, mechanical, mining and electrical engineering, and omitting the specialized instruction usually given where one of these courses alone is followed. A paper of unusual interest was by Prof. Herman Schneider, of the University of Cincinnati, explaining the coöperative engineering courses given at the University of Cincinnati, where the students receive instruction in shop work at manufacturing plants in the vicinity during their college course; such instruction alternating with that given at the college. A remarkably complete record of the careers of graduates in mechanical engineering has been in long preparation by Prof. Franklin DeR. Furman, of Stevens Institute of Technology, and formed the subject of a paper. The teaching of English and foreign languages was discussed, and, while it was apparent that foreign languages are receiving less attention than formerly, there was a strong sentiment in favor of strengthening rather than reducing the courses in English.

ADDRESS ON CONSERVATION OF RESOURCES

The president's address by Dr. Charles S. Howe, president of Case School of Applied Science, upon The Function of the Engineer in the Conservation of the Natural Resources of the Country, was a broad review of the whole problem, giving statistics with regard to our resources and their reduction, and convincing arguments for earnest attention to the subject on the part of engineers. He said in part:

The engineer adapts the forces of nature to the use of men and this adaptation should be done both economically and efficiently. It is not enough to show that a certain force can be made to work when a machine transforms raw into finished product. The work must be done efficiently—that is to say, the greatest amount of good must come from a given expenditure of energy. This makes the machine efficient and shows that it is doing all that it is possible for it to do, and when this is the case it is generally considered that the engineer has successfully performed his duty. * * * The point which I had in mind during the preparation of the paper and to which I wish to give especial emphasis is that this work of conservation is the work of the engineer. I am inclined to think that in some cases the statements in regard to the destruction of our natural resources have been overdrawn and that they will not be totally exhausted in as short a period as some seem to believe, but there is no doubt that the question is a grave one and that it should be faced before it is too late. We should try to avoid waste and unnecessary destruction and we should also try to make the best possible use of all of our resources. It will be the work of the engineer to accomplish both of these objects, and it will also be his province to determine new ways of accomplishing results now so wastefully performed. In the past the engineer has been concerned with getting results. If the results were obtained, the waste and destruction of the natural product has scarcely been considered; but in the future economy of the natural product as well as economy in the final result must receive careful attention. I believe the engineers of the country are capable of solving these problems and that if they are given the necessary governmental and private aid, the problem of the conservation of our natural resources will be solved.

At the sessions of the Society of Automobile Engineers the following papers were read:

Autogenous Welding in Automobile Construction, Mr. E. S. Foljambe; Some Recent Developments in Magneto Ignition, with Special Reference to the Bosch System, Mr. Otto Heins; The Storage Battery in Automobile Work, Mr. Bruce Ford; Unit System of Power Transmission in Automobiles, Mr. Frank Beemer; and Increased Efficiency of Single Motor Drive, Mr. A. L. Dixon.

The American Gas Power Society considered at its meetings the subjects of producer gas engine ratings, tests upon producer gas engines, producers, separately and in combination, and the general standardization of terms used in the description of engines and producers.

THE SOCIETY'S LAND PROBLEM

At the annual meeting last December in New York there was presented the report of the special committee appointed to raise funds to pay the Society's share of the cost of the land on which the new building stands.

By this report, which was placed before all the membership in the Proceedings for December (p. 529), it is seen that of the total amount so far raised $55 500 has come from manufacturing concerns who were asked to contribute on the ground of their interest in mechanical engineering and the work of the Society; the members having subscribed up to that time a total of $15 500.

The complete list of subscriptions received from manufacturing and other firms as it now stands is as contained in the appendix to this report.

As stated in the report referred to above, the present is not a favorable time for subscriptions from manufacturing firms. We shall probably secure a few more of such subscriptions but it would seem as though the membership ought to do much more than has so far been done. As it now stands only about 7 per cent of the membership has subscribed. These are as contained in the appendix.[1]

Of those members who have not subscribed a number have written the committee, expressing sympathy with the work but regretting their inability to subscribe. This leaves a very large proportion of the membership from whom no reply has been received.

It would seem that every member of the Society ought to be sufficiently interested in the Society's welfare to make response to such an appeal in its behalf.

The number of members who have not subscribed being about 2900, and there being yet to raise $73 600, if those members who have not yet subscribed will subscribe an average of $25.38 each, the debt will be lifted from the Society and it will be free to devote its income entirely to lines of activity already inaugurated or in process of

[1] The Society by vote at the annual meeting decided that it would not be advisable to publish the amounts of individual subscriptions.

planning which will enhance the value of membership, especially for those who live at a distance from the headquarters.

A subscription does not necessarily imply immediate payment but only a promise to pay at such time or times as may be convenient for the subscriber.

It is earnestly hoped that every member who reads this will give it his most careful attention; that he will not merely send in his own subscription, but will speak to other members about it and urge them to subscribe as liberally as possible.

There are undoubtedly a few members, who for one perfectly valid reason or another, cannot subscribe the amount mentioned. The deficiency must be made up by others who are fortunately able to subscribe more. If every member does what he is able to do the amount needed will be quickly raised.

We earnestly ask every member to do what he can and to do it immediately.

THE LAND AND BUILDING FUND COMMITTEE
FRED J. MILLER Chairman
JAMES M. DODGE
ROBERT C. MCKINNEY

SUBSCRIPTIONS FROM FIRMS AND CORPORATIONS

Allis Chalmers Co., Milwaukee, Wis.	$1166.67
Almond Manufacturing Co., T. R., Brooklyn, N. Y.	100.00
American Locomotive Co., New York	7500.00
American Pulley Co., Philadelphia, Pa.	300.00
Babcock & Wilcox Co., The, New York	3000.00
Baird Machinery Co., Pittsburg, Pa.	25.00
Bettendorf Axle Co., Davenport, Iowa	100.00
Bickford Drill and Tool Co., Cincinnati, O.	100.00
Billings & Spencer Co., The, Hartford, Conn.	100.00
Bradford Machine Tool Co., Cincinnati, O.	50.00
Bridgeport Brass Co., Bridgeport, Conn.	25.00
Brown & Sharpe Manufacturing Co., Providence, R. I.	1000.00
Brownell Co., Dayton, O.	50.00
Buckeye Engine Co., Salem, O.	100.00
Bullard Machine Tool Co., Bridgeport, Conn.	100.00
Burroughs Adding Machine Co., Detroit, Mich.	100.00
Cadillac Motor Car Co., Detroit, Mich.	50.00
Cincinnati Machine Tool Co., Cincinnati, O.	25.00
Cincinnati Milling Machine Co., Cincinnati, O.	250.00
Cincinnati Planer Co., Cincinnati, O.	50.00
Colt's Patent Fire Arms Manufacturing Co., Hartford, Conn.	100.00
Continental Iron Works, Brooklyn, N. Y.	1000.00

Dreses Machine Tool Co., Cincinnati, O	$50.00
Ellsworth & Co., J. W	3.33
Engineering Magazine, New York	300.00
Engineering News, New York	250.00
Engineering Record, New York	1000.00
Ferracute Machine Co., Bridgeton, N. J	100.00
Fletcher Co., W. A., Hoboken, N. J	100.00
Gisholt Machine Co., Madison, Wis	200.00
Gleason Works, Rochester, N. Y	100.00
Hayes Manufacturing Co., Detroit, Mich	25.00
Heine Safety Boiler Co., St. Louis, Mo	300.00
Hess-Bright Manufacturing Co., Philadelphia, Pa	500.00
Hill Publishing Co., New York	2500.00
Houston Stanwood & Gamble Co., Cincinnati, O	100.00
Industrial Press, The, New York	500.00
Jenkins Bros., New York	250.00
Kennedy Valve Manufacturing Co., The, Coxsackie, N. Y	50.00
LeBlond Machine Tool Co., R. K., Cincinnati, O	100.00
Lidgerwood Manufacturing Co., New York	500.00
Link-Belt Co., Philadelphia, Pa	2000.00
Littleford Bros.,	25.00
Locomobile Co. of America, The., Bridgeport, Conn	100.00
Lodge & Shipley Machine Tool Co., Cincinnati, O	200.00
Lucas Machine Tool Co., Cleveland, O	50.00
Lunkheimer Co., Cincinnati, O	250.00
Machold & Riddell, Philadelphia, Pa	50.00
Massnick Manufacturing Co., Detroit, Mich	25.00
McIntosh Seymour & Co., Auburn, N. Y	100.00
Moore & Co., Chas. C., San Francisco, Cal	250.00
Niles-Bement-Pond Co., New York	5000.00
Quintard Iron Works Co., New York	100.00
Roe Stephens Manufacturing Co., Detroit, Mich	25.00
Sellers & Co., Inc., Wm., Philadelphia, Pa	1000.00
Solvay Process Co., Syracuse, N. Y	5000.00
Triumph Electric Co., Cincinnati, O	50.00
Underwood Typewriter Co., Hartford, Conn	100.00
Union Twist Drill Co., Athol, Mass	100.00
United Engineering & Fdy. Co., Pittsburg, Pa	500.00
Wards Engine Works, Charleston W. Va	150.00
Watson-Stillman Co., New York	500.00
Westinghouse Elec. & Manufacturing Co., Pittsburg	16 667.67
Whitney Manufacturing Co., Hartford, Conn	50.00
Wiley & Sons, John, New York	100.00

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Lardner, Henry A., New York
Larsson, T. L. F., Worcester, Mass.
Lauder, Geo. B., Concord, N. H.
Leland, Henry M., Detroit, Mich.
Leonard, E. I., London, Canada
Lewis, Wilfred, Philadelphia, Pa.
Little, Chas. H., East Cleveland, O.
Lobben, Peder, Holyoke, Mass.
Loring, Chas. H., deceased
MacArthur, Robert, Jr., New Haven, Conn.
Magruder, Wm. T., Columbus, O.
Main, Charles T., Boston, Mass.
Malvern, L. K., Elgin, Ill.
Manning, C. H., Manchester, N. H.
Martell, L. H., Philadelphia, Pa.
Martin, F. S., Pittsburg, Pa.
Marx, Henry, Cincinnati, O.
Mason, Wm., New Haven, Conn.
Mason, Wm. B., Dorchester Center, Mass.
Mattice, A. M., S. Boston, Mass.
Maury, Dabney H., Peoria, Ill.
McMillin, Emerson, New York
Meaker, Guy L., Evanston, Ill.
Meier, E. D., New York
Melville, Geo. W., Philadelphia, Pa.
Merryweather, G. E., Cleveland, O.
Miller, Fred J., Center Bridge, Pa.
Miller, L. B., Elizabeth, N. J.
Miller, Theo. H., Poughkeepsie, N. Y.
Mix, E. W., Mishawaka, Ind.
Moeller, F., Cleveland, O.
Morgan, R. L., Worcester, Mass.
Morrison, H. S., Richmond, Va.
Mount, W. D., Saltville, Va.
Murphy, B. S., Jersey City, N. J.
Murphy, John K., New Haven, Conn.
Murphy, John Z., Chicago, Ill.
Naegeley, John C., Philadelphia, Pa.
Nate, Emile H., Newark, N. J.
Neave, P. M., New York
Norris, R. V., Wilkesbarre, Pa.
Otis, Spencer, Chicago, Ill.
Park, W. R., Boston, Mass.
Parkhurst, F. A., Bridgeton, N. J.
Pettis, C. D., Chicago, Ill.
Philbrick, Frank B., Waterville, Me.
Platt, John, New York
Polson, J. A., E. Lansing, Mich.
Power, Fred M., Solvay, N. Y.
Prather, H. P., Cleveland, O.
Prescott, F. M., Milwaukee, Wis.
Price, A. M., Elgin, Ill.
Quint, A. D., Hartford, Conn.
Quimby, W. E., New York
Rice, Calvin W., New York
Richter, Ernst, Madison, Wis.
Rider, Geo. S., Cleveland, O.
Riggs, John D., Chicago, Ill.
Reed, E. Howard, Worcester, Mass.
Reiss, Geo. T., Hamilton, O.
Reid, Marcellus, Cleveland, O.
Rhoads, G. E., Altoona, Pa.
Robeson, A.M.,Johannesburg, S. Africa
Roper, Norman B., Cudahy, Wis.
Sargent, Fredk., Chicago, Ill.
Satherberg, Carl H., Philadelphia, Pa.
Saunders, W. L., New York
Schaeffler, Joseph C., Boston, Mass.
Scheele, John M. B., New York
Scheffler, Fred A., Glen Ridge, N. J.
Schneider, Paul E., Garfield, N. J.
Schulte, G. H., Milwaukee, Wis.
Schwarz, F. H., Lawrence, Mass.
Smith, E. J., Allentown, Pa.
Smith, Jesse M., New York
Smith, Oberlin, Bridgeton, N. J.
Smith, O. G., Dayton, O.
Snow, Wm. G., Boston, Mass.
Snow, Wm. W., Hillburn, N. Y.
Sprado, Ralph, Chicago, Ill.
Stanwood, J. B., Cincinnati, O.
Starbuck, G. E., New Haven, Conn.
Stetson, G. E., New Bedford, Mass.
Stevens, John A., Lowell, Mass.
Sulzer, J. Carl, Winterthur, Switzerland
Swasey, Ambrose, Cleveland, O.
Sweet, John E., Syracuse, N. Y.

Symonds, Nathaniel G., Indianapolis, Ind.
Terry, C. D., Kewanee, Ill.
Thomas, Charles W., New York
Thompson, A. W., Manchester, N. H.
Thomson, John, New York
Tompkins, Stonewall, Miller School, Va.
Torrance, Henry, Jr., New York
Tower, D. W., Grand Rapids, Mich.
Towle, Wm. M., Enosburg Falls, Vt.
Towne, Henry R., New York
Tufts, Leonard, Pinehurst, N. C.
Turner, John, E. Orange, N. J.
Tuttle, W. B., San Antonio, Texas
Trump, Edward N., Syracuse, N. Y.
Tyler, Chas. C., Ilion, N. Y.
Upson, Maxwell, New York
Van Nostrand, L. G., Scranton, Pa.
Vauclain, S. M., Philadelphia, Pa.
Vaughan, H. H., Montreal, Canada
Veeder, C. H., Hartford, Conn.
Viola, B., Brooklyn, N. Y.
Waitt, A. M., New York
Wallace, D. A., Newark, N. J.
Ward, Charles E., Charleston, W. Va.
Warner, W. R., Cleveland, O.
Warren, John E., Cumberland Mills, Me.
Wehner, Lewis, Milwaukee, Wis.
Wellman, S. T., Cleveland, O.
Weymouth, C. R., San Francisco, Cal.
Wheeler, C. H., Philadelphia, Pa.
Whitaker, H. E., Detroit, Mich.
White, John C., Madison, Wis.
Whitehead, George E., Providence, R.I.
Wicks, Henry, Youngstown, O.
Wildin, G. W., New Haven, Conn.
Willcox, Charles H., Westport, Conn.
Williamson, George E., Bridgeport, Conn.
Willis, E. J., Richmond. Va.
Wolf, Fred W., Chicago, Ill.
Woodbury, C. J. H., Lynn, Mass.
Whyte, John S., Glace Bay, Cape Breton
Young, John P., Youngstown, O.

GENERAL NOTES

INTERNATIONAL CONGRESS OF THE REFRIGERATING INDUSTRIES

There will be held in Paris, October 5 to 8, the first International Congress of the Refrigerating Industries. The delegate of the Society to the conference will be Mr. Gardner Tufts Voorhees, who for this occasion has been made an honorary vice-president by the Council. Through the Department of State Mr. Voorhees has also been appointed a delegate by the United States government. At the sessions of the congress meetings will be held by five sections upon the following general topics:

a Low temperatures and their general effects.
b Refrigerating appliances.
c The application of refrigeration to food.
d The application of refrigeration to other industries.
e The application of refrigeration in commerce and transport.
f Legislation.

Dr. D. S. Jacobus, chairman of the special committee of our Society on A Standard Tonnage Basis for Refrigeration, will present a paper at the congress upon that subject continuing the work which he has so faithfully been conducting for us. The progressive attitude of The American Society of Mechanical Engineers and its coöperation in every movement of this kind for the advancement of engineering progress and for securing uniformity of practice is so well expressed by Dr. Jacobus that we quote the following from his paper:

> The policy of The American Society of Mechanical Engineers has always been for the advancement of the arts, and whereas it is only natural that it should take pride in participating in advancements, it can never look, except with satisfaction, upon similar activities of other bodies, even in the subjects on which it is at work. I feel safe in saying, therefore, that any criticism by the members of this organization on the work which has been done in connection with the subject at hand, will be gladly received. Criticism leads to the establishment of better and more up-to-date methods, and what The American Society of Mechanical Engineers is after, and what I am sure we are all after, is to work hand in hand for the good of the cause.

I also feel safe in saying that The American Society of Mechanical Engineers will coöperate in every way, in the endeavor to establish some standard set of rules which shall conform with the views of such able experts as are congregated here at this meeting, and it is sincerely hoped that the matter presented in this paper will receive a thorough discussion, irrespective of whether those who take part agree or disagree with the findings of the committee.

CONSERVATION OF NATURAL RESOURCES

In accordance with a vote of the Council, June 26, the following Committee on Conservation of Natural Resources has been appointed by President Holman: Prof. George F. Swain, chairman, Mr. L. D. Burlingame, Mr. Charles Whiting Baker, President M. L. Holman, Secretary Calvin W. Rice.

Other organizations which have acted are mentioned herewith.

The National Lumber Manufacturers Association has named a special committee which will hold its sessions in Washington. The American Academy of Political and Social Science has appointed a special committee to offer suggestions and to be of service wherever possible. The National Board of Trade has advised the chairman that it has a committee on conservation of natural resources, and that it expects to call this committee together and give the National Commission detailed and specific information from the standpoint of the National Board of Trade. The American Paper and Pulp Association has offered its coöperation, and through its president announces that the subject will be taken up the present season. Dr. Ira Remsen, president of the National Academy of Sciences, announced that he would bring the whole matter of the conservation of natural resources to the attention of the Academy, and regards it as probable that a committee will be appointed. Mr. J. B. Dort, president of the Carriage Builders National Association, will bring the subject of conservation before his organization with a view to furnishing the national commission specific data in the association's particular field.

The National Commission has been actively at work all summer preparing an inventory of the country's resources, and after these have been reviewed a general recommendation will be made to the President of the United States who in turn will submit the same to the Congress.

LIBRARY ANNOUNCEMENT

It is desired to obtain for the library of the Society by gift, exchange or purchase, the following volumes which will complete important files:

Transactions Naval Architects (of Great Britain), vol. 15, 1874.

Industries (weekly periodical of London), vol. 15, 1893, and Industries and Iron (later title of same), vols. 16 and 17, 1894.

Scientific American, vol. 1, 1845.

During the past six months the files of the following periodicals have been completed:

American Railway Engineering and Maintenance-of-Way Association.

Proceedings.

Railroad Gazette.

Scientific American (excepting vol. 1, 1845).

Master Car Builders Association Proceedings.

COMMITTEE ON INTERNATIONAL STANDARD FOR PIPE THREADS

President Holman has appointed the following committee on an international standard for pipe threads: Mr. E. M. Herr, chairman, and Messrs. Geo. M. Bond, Stanley G. Flagg and William J. Baldwin.

This committee was appointed as a result of the congress at Paris, held under the auspices of the Société Technique de l'Industrie du Gaz en France, and it will have the work of this congress as its basis for future recommendations.

MEMBER'S BADGE FOUND

A member's badge has been found in New York and has been sent to the Society headquarters and turned over to the cashier. It is requested that the owner communicate with the secretary, so that he may secure the return of his property.

MEMORIAL

FRIEDRICH GUSTAV HERRMANN

Friedrich Gustav Herrmann, Privy Councilor of the German government and professor of mechanical engineering at the Technical High School of Aachen, died on June 13, 1907. He is revered by all who know his work as teacher, scholar and engineer.

Professor Herrmann was born December 19, 1836, at Halle a. d. S., the son of a saddler. At the completion of his elementary education, he attended the first class of the provincial trade school of his native city, leaving in 1854 with testimonials of fitness and with the predicate "passed with distinction." From 1855 to March 1859, Herrmann studied at the Royal Trade Institute in Berlin. After he left the High School he was employed as civil engineer in Berlin until 1868, when he entered the fourth deputation (patent board) of the Prussian ministry of commerce as assistant. But he soon turned to teaching, continuing in the work until April 1, 1906, when he was pensioned, at his own request, on account of ill health.

In the fall of 1868, Professor Herrmann accepted a position as tutor in the Royal Academy of Building at Berlin. At the same time, from 1869, he was assistant to the General-Director of Telegraphs and also acted as expert in the Royal City Court of Berlin.

The year 1870 marked a change in Herrmann's professional activity. He accepted a position in the Technical High School at Aachen, as teacher in ordinary of mechanical technology. In the year 1872 he received the title of professor.

Versatile in speech, clear and precise in expression, master of his science, Professor Herrmann was one of the best teachers at Aachen.

His great life work was the continuation, or more strictly speaking, the revision of *Weisbach's Lehrbuch der Ingenieur und Maschinen-Mechanik.* Of this work he himself says, in the preface to the first published volume 1875:

> Through the publishers the honor was offered me of continuing the publication of the fifth edition of *Weisbach's Lehrbuch der Ingenieur und Maschinen-Mechanik,* interrupted by the death of the author. If I accepted, it was not without

being aware of the great difficulties of such an undertaking, or without the consciousness that I must apply all my strength and assiduity to the work, in order to any extent to justify its assignment to me. How far I have accomplished this last, I must leave to the judgment of the reader. I can at least assure him that I have not failed in assiduity.

No one who looks in even a cursory manner at that work of seven volumes, the last of which appeared in 1901, will need any other assurance of Professor Herrmann's industry and scientific knowledge. With a wonderfully comprehensive knowledge of literature, Herrmann knew how to present with fine clearness and simplicity both things already known in a new way, and the new results of his own research. The latter are recorded in a number of works the greater part of which appeared in technical journals, although in some cases his work was presented in book form. His scientific activity was appreciated beyond the sway of the German language and translations of some of his chief works were made into English and other languages.

Professor Herrmann was very active as a member of the *Verein deutscher Ingenieure.* Among the numerous honors which he received he was made councilor by the government and received the degree of Honorary Doctor of Engineering from the Technical High School of Karlsruhe.

NECROLOGY

HENRY WALLACE CAKE

Henry Wallace Cake, superintendent of the mills of the Calumet and Hecla Company, died at Lake Linden, Mich., April 21, 1908. He was born in Pottsville, Pa., March 5, 1850, and received his education in the common schools of his native state; at the age of 13 years becoming a helper in an iron foundry. Later he served three years as apprentice in a machine shop in Pottsville, worked as a machinist in a number of stationary engine and locomotive shops, and in 1887 took charge of locomotive erection in the Baldwin works, at Philadelphia; in May 1889 he became assistant superintendent of the Calumet and Hecla mills at Lake Linden, Mich., was made acting superintendent in 1901 and superintendent two years later.

FRED N. FOWLER

Fred N. Fowler died at Holyoke, Mass., May 16, 1908. He was born in Stratton, Vt., June 14, 1853. Mr. Fowler was self-educated, and rose in his profession by dint of perseverance and application. For 25 years he had been associated with the United Electric Light and Power Company, of Springfield, acting as superintendent, and at the time of his death, as consulting engineer.

STERLING B. COX

Sterling B. Cox was born at Milburn, N. J., January 28, 1878, and died at East Orange, N. J., May 22, 1908. He was graduated at Harvard in 1900; was for several years with the Lackawanna Steel Company at Buffalo and New York, and subsequently secretary of the East Jersey Pipe Company.

JOSEPH STONE

Joseph Stone, born in Charlestown, January 4, 1848, was a member of the first class graduated from the Massachusetts Institute of Technology, graduating in 1868 with the degree of S.B. From 1868 to 1873 he was engaged as mechanical engineer in the building and remodeling of textile mills; from 1873 to 1880 was agent of the Manchester, N. H., Mills, and from 1880 to 1887 was similarly in charge of the Lower Pacific Mills in Lawrence, Mass. He then retired from active business, devoting his time to his real estate interests.

Mr. Stone was a member of the Technology Club of Boston. He was a man of retiring disposition, but of rare business tact and sterling character. His home for the last few years was in Brookline, Mass., where he died suddenly from heart failure, May 24, 1908.

WILLIAM A. PEARSON

Mr. William A. Pearson, for 16 years chief architect and superintendent of buildings for the General Electric Company, at Schenectady, N. Y., died in that city May 26, 1908. He was born at Athens, Bradford county, Pa., July 29, 1855. After graduation from the Sayre, Pa., high school in 1870, he served his apprenticeship to the machinist's trade in the D., L. & W. Railroad shops in Scranton, Pa., where he was foreman two years. He was journeyman machinist and locomotive engineer with the Union Pacific Railroad in Omaha, Neb., and afterwards foreman of shops at Carson City, Nev. He then went to Virginia City, where he became superintendent of the Comstock mines, but resigned to engage in mining business with headquarters in New York. He afterwards became superintendent of the marine department of the Dickson Manufacturing Company in Scranton, later occupying a similar position with the Boies Wheel Company in the same city. His connection with the General Electric Company followed.

FRED. A. JOHNSON

Fred. A. Johnson, president of Gisholt Machine Company, of Madison, Wis., died in Denver, Colo., May 26, 1908. He was born in Madison, Wis., September 14, 1862, and was therefore 46 years old at his death. He attended the mechanical engineering course of the University of Wisconsin three years with the class of 1884, afterwards spending a number of years in the agricultural implement

shops of the Fuller & Johnson Manufacturing Company, of Madison, where he rose to the position of assistant general superintendent. In 1885 he joined his father and brothers in the organization of the Gisholt Machine Company, and in 1901 became its president. Up to 1904, when illness prevented, he took an active part in the management of the business and spent several years in Europe in the interests of the company. He was an associate member of the Institution of Mechanical Engineers.

HARRIS TABOR

Harris Tabor was born in Clarence, Erie county, N. Y., January 26, 1843, and died at his home in Philadelphia, July 29, 1908, as the result of an automobile accident which occurred July 4, 1907, in which accident Mrs. Tabor was also severely injured.

Mr. Tabor was a charter member of the Society; attended the meetings preliminary to its formal organization as well as most of those held afterward, and took an active interest in the Society's welfare.

Receiving in his native place a common school education, he supplemented this as occasion arose by study along the special lines in which be became interested. At 16 he engaged as an apprentice in the shop of his brother, Leroy Tabor, Sr., at Tioga, Pa. Two years later he enlisted in the Union army and served two years in the Civil War, after which he was employed by S. Payne at Troy, Pa., as a machinist, afterward becoming superintendent of the shops of B. W. Payne & Sons at Corning, N. Y., and later of the shops of the Hartford (Conn.) Steam Engine Company. He was then for some years with the Westinghouse Machine Company at Pittsburg. A student of steam engines, he devised various improvements upon them and his "Tabor" indicator is well known to engineers, being one of the first of such instruments capable of correctly indicating high-speed engines. In the Westinghouse establishment be became interested also in foundry matters, especially in the problems of molding by power driven machines, and became one of the highest authorities on them. He finally organized the Tabor Manufacturing Company, New York, and was its president for a number of years, but finaly sold out most of his interest and the company was then removed to Philadelphia. After a few years, however, he again became active in its affairs.

Mr. Tabor devised the first successful power molding machine in which the ramming was done by an overhead inverted steam cylinder; introduced compressed air for working such machines and invented

the "vibrator" for molding machines; a device which greatly facilitates the drawing of difficult patterns. Very recently he had devised important improvements and was at work upon others when disabled by the unfortunate accident which caused his heath.

THE JOURNAL

OF

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THE season of professional meetings of the Society will be opened on Tuesday evening, October 13, by a meeting of the Gas Power Section in the Engineering Societies Building. Two papers will be presented and two important matters discussed at this meeting. One by Mr. E. A. Harvey upon producer gas plants gives data on costs and performance, and describes three different plants with details as to their layout. The other, by Mr. N. T. Harrington, gives the results of tests to determine the loss of fuel weight in a freshly-charged producer, due to the gradual increase of ash contents in the fuel bed. Both of these papers are published in this number of The Journal and lantern slides will be used by Mr. Harvey to supplement the illustrations accompanying the text of the paper.

A subject of the utmost importance in gas power is that of standards. There can be no satisfactory comparison of results or statement of operative conditions as long as there is no general agreement as to units and methods. In the September number of The Journal was published a comprehensive progress report submitted by the Committee on Standardization of the Gas Power Section which will form the basis of a discussion at the October meeting.

Another subject to be discussed is the plan presented in this number in a communication by Mr. H. L. Doherty, Chairman of the Meetings Committee of the Section. The great importance of the present developments in the gas power field, and the rapidity with

which positive results are being attained, make a comprehensive program of work for the Gas Power Section most desirable, and the Meetings Committee of the Section propose to enter into a plan for presenting a broad and logical treatment of the whole subject. This includes a plan for the complete bibliography of the subject of gas power, including books and magazine articles; a classified list of all patents relating to gas power; a complete list of all gas power plants at work, with information about their degree of success; a bureau of advice and information; the adoption of a method for comparing results of gas and steam power plants; the securing of operative information; discussion on railway and marine propulsion, turbines, transmission of power, commercial, manufacturing, technical and scientific questions.

The Annual Meeting

IMPORTANT ANNOUNCEMENT UPON AERONAUTICS

The annual New York meeting will be held December 1 to 4 inclusive and the Secretary is glad to announce that arrangements have been completed through the courtesy of the Secretary of War, General Wright, and the Chief of the Signal Service, Brigadier General Allen, for a comprehensive presentation at this meeting of the subject of aeronautics. At this time—literally during the past few weeks—years of laborious efforts by aviators in different parts of the world have culminated in a degree of success that is nothing short of remarkable. Zeppelin, Baldwin, Farman, Curtiss, Wright and others whose recent achievements are familiar to all, have made an effective start toward the complete solution of the problems of balance, steering, propulsion and continued flight. The patient work of the many equally notable experimenters who have preceded them has made their success possible. The science of aeronautics has gradually developed until now notable progress is to be recorded, and it is appropriate that The American Society of Mechanical Engineers not only recognize but emphasize the far-reaching importance of this development at its meeting.

At the Professional Session on Wednesday, December 2, a paper will be presented by Major Geo. O. Squier, Acting Signal officer, U. S. A., Washington, D. C., treating exhaustively the problems of aviation and methods tried for their solution, and will point out how the engineer can help in their further and complete solution. The collection of data and material sent in by the attachés at the

capitals of the world, at the disposal of Major Squier for the preparation of this paper is the most complete in the country and perhaps in the world, and it is believed that his paper, presented at this time, will mark an epoch in the annals of the Society.

On the evening of the same day Lieut. Frank P. Lahm of the Signal Corps will deliver a popular lecture on the same subject, with moving pictures, to which the members and guests, including the ladies, are all cordially invited.

Definite announcement of these features is made thus early, in order that members may arrange to be in New York on the day of these two sessions. It is expected that the interest in the subject will be so great that many who would not otherwise attend the annual meeting will make unusual efforts to do so.

MACHINE SHOP SESSION

As previously announced, one session of the annual meeting will be devoted to machine shop practice, with several strong papers upon new developments, especially in milling machines and cutting tools. Related to this general subject also will be a discussion on gear tooth standards, covering designs and material used to secure durability and strength in various fields, such as rolling mill and electric railway work, hoisting machinery, automobile construction, etc., in all of which the duty is so severe as to require extraordinary precautions to secure even commercially good results.

In addition to the papers upon the subjects above enumerated a great variety of miscellaneous papers is already prepared and also is in preparation for this meeting, announcement of which will be made later.

THURSTON MEMORIAL

TABLET ERECTED TO THE MEMORY OF DR. ROBERT HENRY THURSTON

Our frontispiece this month is a photograph of the memorial tablet presented by the alumni of Sibley College and unveiled at Cornell University on June 16, 1908, in memory of Robert Henry Thurston, for many years Dean of the College of Engineering. The ceremonies were the occasion for the return of many alumni of Sibley College whose training was under Doctor Thurston's direction.

Prof. R. C. Carpenter, a colleague of Doctor Thurston, presided. In a brief opening address he said that this was the occasion for commemorating the memory of the greatest teacher of engineering the world has ever produced. He mentioned that the tablet presented was largely a labor of love by one of Dr. Thurston's former students, Hermann A. McNeil. The memorial was provided by the undergraduate students at Sibley College at the time of Dr. Thurston's death in 1903, and by the Sibley alumni.

The address by J. H. Barr paid a tribute to Doctor Thurston as a scholar, engineer, investigator, author, teacher and administrator. It gave a short sketch of his career as a teacher of engineering, beginning with his work at Stevens Institute, where he was the leading spirit in shaping the new scheme of engineering education, and later at Sibley College where his methods had full scope. Mr. Barr said that, giving all honor to Doctor Thurston's work as an investigator and writer, his greatest accomplishment was his noble and beneficent influence on the thousands of young men whose lives and careers were touched by him.

H. P. DuBois, Chairman of the Student Committee of the Memorial Fund, said Doctor Thurston was a great teacher, a great organizer, a great executive, but a greater man. At the close of the address by Mr. DuBois, the memorial was declared dedicated.

Addresses were also delivered by former President Andrew D. White, and Director Albert F. Smith.

The tablet is of bronze and is the work of Hermann A. McNeil, a student and later an instructor in the Department of Drawing in

Sibley College. It will ultimately be mounted on the right of the entrance to the Sibley Dome.

Doctor Thurston was the first president of the Society, and was twice elected, 1880–1882. A list of the papers written by him for the Society may be of interest: The Ratio of Expansion at Maximum Efficiency; The Proper Method of Expansion of Steam and Regulation of the Engine; Our Progress in Mechanical Engineering (Presidential Address); The Several Efficiencies of the Steam Engine, and the Conditions of Maximum Economy; The Mechanical Engineer, his Work and his Policy (Presidential Address); A Newly Discovered Variation in the Effect of Prolonged Stress on Iron; Water Hammer in Steam Pipes; Pressure Obtainable by the Use of the Drop Press; A New Theory of the Turbine; Theory of the Sliding Friction of Rotation; Steam Boilers as Magazines of Explosive Energy; The Theory of the Finance of Lubrication, and The Valuation of Lubricants by Consumers; The Friction on Non-condensing Engines; Helical Seams in Boiler Making; The Systematic Testing of Turbine Water Wheels in the United States; Internal Friction of Non-condensing Engines; Proportioning Steam Cylinders; Large and Enlarged Photographs and Blue Prints; The Distribution of Internal Friction of Engines; Variable Load, Internal Friction, and Engine Speed and Work; Philosophy of the Multi-cylinder or Compound Engine, its Theory and its Limitations; Hirn and Dwelshauvers' Theory of the Steam Engine, Experimental and Analytic; Chimney Draft: Facts and Theories; Authorities on the Steam Jacket: Facts and Current Opinion; Steam Engine Efficiencies: The Ideal Engine Compared with the Real Engine; Technical Education in the United States; The Maximum Contemporary Economy of the High-Pressure Multiple-expansion Steam Engine; The Theory of the Steam Jacket, Current Practice; Superheated Steam, Facts, Data and Principles; The "Promise and Potency" of High-pressure Steam; Multiple-cylinder Steam Engines; Graphic Diagrams and Glyptic Models; The Steam Engine at the End of the Nineteenth Century; Reheaters in Multiple-cylinder Engines; The Steam Turbine: The Steam Engine of Maximum Simplicity and of Highest Thermal Efficiency.

A memorial giving a complete account of Doctor Thurston's life and works is published in Transactions, Vol. 25, 1904.

GENERAL NOTES

EXCHANGE OF COURTESIES WITH SISTER SOCIETIES

The Society took advantage of the trip to Europe of our Honorary Councillor and Past President, Mr. Ambrose Swasey, to present through him the greetings of the Society to the English societies in London, and to extend the courtesies of the rooms and library to their members when in America.

Mr. Swasey's visits were received with marked appreciation and the Secretary has received very cordial letters from the societies visited.

FORESTRY ON THE BILTMORE ESTATE

The members of the Society are invited by Mr. Chas. E. Waddell, Mem. Am. Soc. M. E., and consulting engineer of the Biltmore Estate, Biltmore, N. C., to attend the celebration of the twentieth anniversary of forestry on the estate, and the tenth anniversary of the Biltmore Forest School, which will be held November 26, 27 and 28.

The first experiments in forestry on American soil were made on this estate, and the results achieved will doubtless be both interesting and instructive to engineers generally and especially to the many who are directing special attention to the relation of engineering to forestry.

There will be excursions over the Biltmore Estate, inspection of forest plantations of hard and soft woods made between the years 1889 and 1905, the study of planting operations in actual progress and a lecture by Director C. A. Schenck explaining the purposes from a silvicultural and financial standpoint. Excursions to other forests, fishing and shooting are features of the social entertainment.

Members desiring to accept the courteous offer of the Biltmore Estate may address Dr. C. A. Schenck, Director, or Mr. Charles E. Waddell, Engineer, Biltmore, N. C., who will advise regarding accommodations and rates.

EMPLOYMENT BULLETIN

The Secretary has recently received numerous calls either by letter or by telephone for men for various positions, thus indicating a substantial improvement in business.

This feature of the Society's activities is of direct benefit to the membership in two ways; first, members or others desiring competent engineers will, through the medium of the Society, obtain the names of reliable men; and second, members who may be temporarily in the search of a position or desiring to improve their positions may through the Secretary's office get in touch with firms desiring their services.

The Secretary not only gives this work his personal attention, but takes especial satisfaction in it and invites inquiries.

MEMBERSHIP IN THE GAS POWER SECTION

The Society is pleased to give below a list of its members who have been elected to membership in the Gas Power Section.

George T. Atwood
C. H. Benjamin
A. Bement
William Hutton Blauvelt
Henry R. Cobleigh
E. P. Coleman
George N. Comly
C. J. Davidson
C. H. Doebler
Edwin D. Dreyfus
Louis C. Doelling
John T. Faig
A. K. Fischer
J. H. Fox
Floid M. Fuller
Chas. L. Griffin
Harris R. Green
N. T. Harrington
Jos. L. Hiller
Chas. A. Howard
H. S. Isham
Robt. T. Kent
George Kirk
G. L. Knight
Ralph Morley
L. N. Ludy
Chas. W. Lummis
F. V. McMullin
V. E. McMullem
Fredk. H. Mason
H. B. MacFarland
Lionel S. Marks
George A. Orrok
John C. Parker
Wm. H. Parish
J. A. Polson
Geo. J. Rathbun
Chas. R. Richardson
Orlando J. Root
Chas. B. Rearick
Godfrey M. S. Tait
C. H. Trent
Clifton W. Wilder
B. N. Wilson
Arthur J. Wood
E. R. Wood, Jr.
Samuel S. Wyer
Gilbur A. Young
Oliver B. Zimmerman

The following are applicants for membership in the Gas Power Section and also applicants for membership in the Society.

Frederick N. Connet
Tomlinson C. Ulbricht
George F. Caawley

The following are Affiliate Members of the Gas Power Section, but not members of the Society.

Roscoe D. Addis
John H. Barker
Chas. G. Burton
J. D. Cudney
H. T. Eddy
A. R. Foot
John W. Hamilton
Chas. F. Hopewell
Edward M. Hunt
Edwin H. Jewett
Fred L. King
Henderson W. Knott
Robert T. Lozier
Gustavus T. Luckett
R. S. de Mitkiewicz
Ernest L. Ohle
Richard F. Rearden
Lewis D. Rights
Darrow Sage
Roy Bassett Shoop
Harvey A. Soverhill
Samuel C. P. Vosper
Geraldo Waldo
George W. Whyte
T. H. Yawger

THE INTERNATIONAL CONGRESS OF REFRIGERATING INDUSTRIES

Several members of the Society will participate in the International Congress of Refrigerating Industries to be held in Paris, France, October 5 to 10. Mr. John E. Starr, the vice-president of the American Committee of the Congress, and Mr. Gardner T. Voorhees of Boston, are expecting to be present and give papers as follows: Mr. Gardner T. Voorhees on "Comparison of the Production of Cold by Compression of Liquefiable Gases and Other Methods;" Mr. John E. Starr on "Construction of Cold Stores and Arrangement of Refrigerating Appliances." Other members who are preparing papers are, Prof. D. S. Jacobus on "Standardization of Refrigerating Measures;" Mr. Louis Block on "The Ice Making Industry of the United States;" Mr. James E. Gayley on "The Use of Refrigerating Machinery in the Manufacture of Pig Iron."

The Congress is held under the patronage of the French Ministers of Agriculture, Commerce and Industries, and the arrangements are in the hands of a committee of men prominently identified with the refrigerating industries of France, government officials, etc.

An invitation was extended to the United States Government to participate in the congress, and delegates have been appointed to

represent officially the government at Paris. Bureau officials have also been designated to prepare papers on subjects that have been under departmental investigations.

The purpose of the congress is to bring together the leading experts and representatives of the different industries and enterprises of all countries in which refrigeration is used as an agent for facilitating the preservation and transportation of food products by land and sea, and through a conference of practical and scientific men to improve and perfect the production and application of mechanical refrigeration.

America is a natural source of supply of many food products for densely populated Europe, and the influence of this congress should be to break down technical barriers and smooth a way for mutual understanding and for an enlarged trade. It should also call universal attention to the benefits derived from refrigeration, and would prove a powerful factor in creating public sentiment favorable to cold storage products and help to remove the prejudice against foods preserved in cold storage, and disseminate accurate information regarding the hygienic advantages of refrigeration. It would no doubt lead to an extension of the present market for refrigerated products and the means of producing refrigeration.

French, German and English will be the languages used, and a complete set of the published papers will be secured for the library.

Elaborate arrangements have been made by the French General Committee for the social entertainment of the delegates of the congress. More than three hundred expect to attend from the United States, and in this number are included members of every branch of the refrigerating industry.

The committee of this Society for determining a Standard Tonnage Basis for Refrigeration, and for preparing a Code of Rules for Conducting Tests of Refrigeration Machines, is composed of Prof. D. S. Jacobus, Chairman, Mr. Philip deC. Ball, Prof. E. F. Miller, Mr. A. P. Trautwein, Mr. G. T. Voorhees. Prof. D. S. Jacobus will present to the congress for discussion on behalf of the Committee the preliminary rules which they have tentatively prepared for this Society, and other features of the problem, with a view to obtaining the widest possible discussion and the opinions of those interested in refrigerating industries.

OLD YEAR BOOKS OF THE SOCIETY

The Secretary is preparing a complete record of all those who have been members of the Society at any time; in order to do this it will be a convenience to have the old Year Books, and any published previous to 1906 will be appreciated by the Secretary if forwarded to him.

MEMBERSHIP COMMITTEE

A Committee of the Society meriting particular approval for its work is the Membership Committee. Night after night throughout the year the members of this Committee meet, frequently at personal sacrifice. The confidential records of applicants are most conscientiously scrutinized, weighed and graded, or rejected entirely as the case warrants. The very life of the Society depends on their painstaking and judicial work. Appreciation of this labor is best acknowledged by the membership by themselves reading the blue professional record giving the statements of the applicants and sharing with the Committee the responsibility of receiving the applicants into the membership. This blue circular is intentionally issued one month in advance of the ballot to allow time for the members to consider the application.

In this connection, however, it ought to be stated that whereas this consideration of applicants is work, it is not a task, as it is most generously undertaken by the Committee. Another desirable form of acknowledgment is for the membership to try to secure more members. Every engineer, no matter what his eminence, should consider it his duty to be enrolled as a member of one of the great societies and to participate by such membership at least in the promotion of the art.

MEMORIAL WINDOW IN WESTMINSTER ABBEY TO SIR BENJAMIN BAKER

The Institution of Civil Engineers of Great Britain have secured permission for the erection of a memorial window in Westminster Abbey for the late Sir Benjamin Baker, former President of the Institution and Honorary Member of this Society, whose death occurred May 19, 1907. The Council of the Society have signified their desire to participate to the amount of 25£ in the erection of this window. The Society is naturally desirous to participate in the subscription to this memorial, but as its funds may not be so used, any

subscription must be made by members individually. The Council would be pleased if the membership responded generally and permitted the Society to forward the amount in its name.

This recognition has been given to engineers in but few instances, being restricted to a statue of Telford, a bust of Watt, and memorial windows to Robert Stephenson, Joseph Locke and Sir William Siemens. The Institution also wish to place a similar memorial window in their new home and the Council have made a subscription for this purpose.

The designs for the window in Westminster Abbey are in the hands of the Ecclesiastical Authorities, subject of course to the approval of the Committee of the Institution, and if we are able to obtain a photograph of the accepted design when it is complete, the members may expect to see an engraving of it in a future issue of The Journal.

GEORGE WESTINGHOUSE, HONORARY MEMBER, AM.SOC.M.E.

Through the kindness of Mrs. Westinghouse an excellent protrait of George Westinghouse has been presented to the Society. The Society is now in possession of two portraits of him, one in crayon, made in 1884, at which time Mr. Westinghouse was 37 years of age. This crayon was presented by Mrs. Forney, included in the gift of the library of Matthias Nace Forney which was recently presented to the Society. The portrait we have just received is the latest taken of Mr. Westinghouse and is pronounced by all to be most satisfactory. The Society is very grateful to Mrs. Westinghouse for her kindness.

MEETING OF THE AMERICAN INSTITUTE OF MINING ENGINEERS

The ninety-fifth meeting of the American Institute of Mining Engineers is at session at Chattanooga, Tennessee. The meeting opens Thursday evening, October 1, and sessions for reading and discussion of professional papers will be held Thursday, Friday and Saturday. On Tuesday, October 6, there will be an excursion to Duck Town, Tennessee, returning to New York by way of Chicago, Friday, October 10.

OCTOBER MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The October meeting of the American Institute of Electrical Engineers, will be held in the Auditorium of the Engineers' Building, 33

West Thirty-ninth street, New York, on Friday, October 9, 1908, at 8.00 p. m. At this meeting a paper entitled, "High-Potential Underground Transmission," by P. Junkersfeld and E. O. Schweitzer of the Commonwealth Edison Company, Chicago, will be presented and discussed.

THE JOURNAL

OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

VOL. 30 MID-OCTOBER 1908 NUMBER 9

THE November meeting of The American Society of Mechanical Engineers will be held in the Engineering Societies Building on Tuesday evening, November 10. Mr. Franklin Phillips, president of the Hewes & Phillips Iron Works, Newark, N. J., will make an address on The High Powered Rifle and its Ammunition—Instruments of Precision, illustrated by lantern slides.

Mr. Phillips is an expert marksman and in 1903 won the position as first alternate on The International Rifle Team to England. He was for many years chairman of the Committee on Rifle and Pistol Practice in the National Guard of New Jersey and is now Ordnance Officer of the Second Infantry of that State.

Tests of rifles and ammunition at Sea Girt, N. J., by men connected with the New Jersey National Guard have led to marked improvement in arms and ammunition and to an entire change in the powder used by the government, thereby greatly increasing the accuracy of the shot. The improvement has been extended to large guns in the army and navy and instead of the 2 per cent of hits which were made at Santiago, 80 per cent is now the average on some ships.

Annual Meeting

With this number we begin the publication of papers for the Annual meeting. A considerable number of papers to appear in subsequent issues of The Journal are already in the hands of the Meetings

Committee for consideration and there is a list of promising papers yet to be received on a variety of attractive subjects. The latest date at which the committee can undertake to pass upon papers for this meeting is November 1, and in general papers should be in hand before this.

Two important subjects of a practical character to come up for discussion are milling machine practice, with results of tests upon cutters and an outline of the principles of design; and the stub gear tooth, which has been developed for heavy duty, such as is required in automobile work, in electric railway work and in rolling mill practice.

There will also be several papers upon other important branches of engineering, giving unusually valuable data. These papers include the subjects of steam engineering and gas power engineering. Announcement of authors and titles of papers will be made in a later number.

AERONAUTICS

The Society is especially favored by the opportunity of securing from the most authoritative source, namely, the Signal Service of the Department of War, not only information respecting the record tests of aeroplanes at Fort Myer, but also information from the military attachés abroad respecting the advance of aeronautics in other countries. Major Squier, Acting Chief Signal Officer, will make an address at the Wednesday morning session of the Annual meeting in which he will give an account of the state of the art in all countries as well as in America. He is an accomplished speaker and a well known author, and the features he will bring out in his address, in addition to the description and the scientific explanation of the working principles of the aeroplane, will be statements of several unsolved problems in which mechanical engineers may participate, thus making the address of direct and practical benefit to every member of the Society.

In the evening of the same day Lieutenant Lahm, who has taken part in the experiments both at Fort Myer and St. Louis, will give an address, less technical in nature, for the benefit of the membership, ladies and guests, illustrated by many beautiful slides and moving pictures of the flight at Fort Myer. This address will be profusely illustrated in the December number of The Journal, which will be issued November 25, and every member should make arrangements to secure the number before leaving for the convention. If he can

not receive it through the ordinary mails, he should notify the Secretary, who will hold a copy subject to his call at the convention.

FORWARD WORK OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Attention is called to the paper by Mr. Morris Llewellyn Cooke in this number. Every member should read this paper, which will probably be presented at the Wednesday morning session of the Annual meeting, immediately following the business session. The paper deals with the broad work that a national engineering society may undertake, and every individual so fortunate as to participate in such a movement should benefit from it.

It was with this broad public spirit that our Society took the prominent part in the movement for conserving the natural resources of our country, which resulted in the conservation meeting last spring and was addressed by Dr. McGee, Dr. Pritchett, Dr. Swain and Dr. Goss, and in an invitation from the President of the United States to participate in the Conference of Governors at Washington.

There are other avenues, notably in research, in which the Society may take a prominent part.

DEVELOPMENT OF THE JOURNAL

The development of The Journal, with its greater variety of contributions, improvement in appearance, increased number of illustrations, information regarding meetings of other societies and other improvements which will be undertaken, is forward work which is made possible only by the corresponding development of its advertising pages. It is therefore for the benefit of every member that the advertising in The Journal be increased. The entire income from this source will be spent for the further improvement of the publication.

It is the aim to make The Journal so important that it will be the medium for bringing out strictly technical matter which might be too technical for the trade periodicals. The work of The Journal is in no sense competitive with any other existing American publication. It is an attempt to establish a journal in a field of its own. Suggestions are cordially invited along all lines to make this work of the Society a signal success.

PERSONALS

With this issue of The Journal we begin a column of "Personals" which will give a brief account of the changes in the business relations

of the members. When a request is made to change a business address, the member should give full information in regard to the change for the "Personals" page, otherwise the Society must write for it and when this is necessary the news often cannot be published in the issue of The Journal immediately following.

The Journal proposes to develop the personal news, and solicits information in regard to the latest business movements of members and other matter of a personal nature.

INCREASE IN MEMBERSHIP

On account of the strictness with which the Society now conducts the inquiry into the qualifications of applicants for membership, many are possibly deterred from making applications. The work of the Membership Committee can be greatly lessened by care on the part of the members to advise prospective applicants to make their statements quite complete, and to refer invariably to men personally acquainted with their work. It is obvious that it is for the good of the profession that conscientious work on the part of the Membership Committee be uniformly performed. On the other hand, quite active efforts should be made by members to increase the membership by inviting leading men in all branches of engineering to apply for membership. Many prominent engineers and men who are doing splendid engineering work are not members of any society, and it is natural that they should want to be associated with some organization which promotes the work of the engineering profession, if the advantages of membership were sometimes brought to their attention.

FINANCIAL CONDITION OF THE SOCIETY

The financial condition which has prevailed throughout the country has had its effect upon the payment of dues. In order to carry on its work in the profession, the Society must be financially successful. While the program of activities is laid out, the members will appreciate that the failure to remit the payment of dues must have its effect on the progress of the Society and make it necessary to curtail some of its activities.

The financial condition is sound, as the members will see by the forthcoming report. The several funds have been rehabilitated, namely, the Library Fund, the Weeks' Legacy, Life Membership and

the Thurston Memorial, and these funds are invested in New York City bonds, bringing a return of about 3½ per cent. For the first time the Society is enjoying this condition.

JOINT COMMITTEE ON ENGINEERING EDUCATION

At the last annual convention of the Society for the Promotion of Engineering Education a resolution was introduced and adopted which invited the leading societies of engineering to appoint a Joint Committee to study engineering education. The movement met with the interested coöperation of the societies invited, which appointed Committees, the personnel of which are remarkably equipped for such important work. They are composed of graduates of the most prominent technical schools and colleges of America, and several of the members are professors in the prominent technical colleges and at least one-half have received the degree of Doctor of Science or Doctor of Philosophy. Most of the Committee have also served as presidents of the national societies which they represent. We mention this to emphasize the valuable equipment which the Committee possess for the comprehensive work of directing engineering research, investigating and recommending courses in graduate work, under-graduate engineering instruction, and the proper relations of engineering schools to the secondary industrial, or foremen's schools.

It is proposed to carry on the work by holding a series of conferences in which the most notable teachers in engineering and branches relating to engineering will be asked to take part, regardless of whether they are members of the Committee. The results of these conferences and the final conclusions of the Committee will be embodied in a report upon "The proper scope of engineering education and the degree of coöperation and unity that may be advantageously arranged between the various engineering schools."

Industrial and engineering education have been widely discussed in the past. The American Society of Civil Engineers have evinced their concern in the subject by the appointment of a special committee to study the problem of engineering education; the American Institute of Electrical Engineers appointed a committee to study electrical engineering education, and it has been discussed before the American Chemical Society. This Society discussed the present status and needs when the papers by Mr. M. W. Alexander on "A

Plan to Provide a Supply of Skilled Workmen," by Prof. John Price Jackson on "College and Apprentice Training," and by Mr. W. B. Russell on "Industrial Education," were presented. These papers excited a great deal of discussion which brought out the universal need for action.

Dr. Frederick W. Taylor of Philadelphia, Past President of the Society, and Dr. Alex. C. Humphreys, President of the Stevens Institute of Technology, two members of the Society well qualified, by reason of their training and appreciation of the relation of the theoretical and practical and their broad outlook for the needs of the profession, were appointed upon this important committee.

The following appointments were made by the other national engineering societies:

The American Society of Civil Engineers, Mr. Desmond Fitzgerald and Mr. B. M. Harrod, Past Presidents; The American Institute of Mining Engineers, Prof. Henry M. Howe and Mr. John Hays Hammond, Past Presidents; The American Institute of Electrical Engineers, Dr. Samuel Sheldon and Mr. Charles F. Scott, Past Presidents; American Chemical Society, Prof. H. P. Talbot and Mr. Clifford Richardson; The Society for the Promotion of Engineering Education, Prof. C. L. Crandall, Cornell University, and Prof. D. C. Jackson, Massachusetts Institute of Technology, and Prof. James M. White, University of Illinois. The Chairman of the Committee is Mr. Desmond Fitzgerald, the Secretary and Treasurer is Dr. Samuel Sheldon and the Executive Committee is composed of Messrs. Fitzgerald, Sheldon and Jackson.

FIRST MONTHLY MEETING

The October meeting of the Society was in charge of the Gas Power Section. It was held in the Engineering Societies Building on Tuesday evening, October 13, Dr. C. E. Lucke, President of the Section, presiding. A report for the Membership Committee was given by Mr. George A. Orrok, showing an increase of 123 in the membership of the Section since September 1.

The opening discussion was upon the communication from Mr. H. L. Doherty, Chairman of the Meetings Committee of the Section, published in the last number of The Journal, outlining a definite plan of action for the section. Messrs. Tait, Rushmore, Bump, Wilkinson, Dr. Lucke and Prof. Reeve participated in the discussion. Suggestions were made regarding information upon the reliability of gas

engine installations, particularly urging that this information be authentic; to the effect that engineering data could be effectively distributed by the adoption of a "Question Box;" that data should be gathered and filed at Society headquarters; and that questions to be considered by the Section should include those involving precise knowledge and investigation as well as constructive and operative problems.

The Progress Report of the Committee on Standards, published in the September Journal, was discussed at length by Messrs. C. W. Lummis, Bibbins, and Prof. Reeve, the discussion hinging mainly on gas engine efficiency and heat value of gas, with arguments for the use of total heat values and effective heat values.

The first paper of the evening was by Mr. E. A. Harvey on Bituminous Producer Plants, giving data upon the cost and performance of three different plants. This was illustrated by lantern slides and discussed by Messrs. Tait, Parker and Bibbins. A paper on the Loss in Fuel Weight in a Freshly Charged Producer, by N. T. Harrington, owing to the lateness of the hour, was not discussed. Both these papers were published in October Proceedings.

PERSONALS

Mr. J. C. Bertsch, Refrigerating Engineer and Architect, Macon, Ga., opened, on October 1, a consulting engineering office in Atlanta, Ga.

Mr. Howard L. Bodwell is now located at Vandergrift, Pa., as Assistant District Master Mechanic, with the American Sheet and Tin Plate Co.

Mr. Dwight S. Cole has recently been engaged by the Dake-American Steam Turbine Co., Grand Rapids, Mich., in the capacity of Designer.

Mr. Francis J. Cole of the American Locomotive Co., New York, has been transferred to the Schenectady, N. Y., office of that company.

Mr. Arthur W. Cushman, former Superintendent of the Springfield Provision Co., has accepted a position with Swift & Co., Chicago, Ill., as Division Superintendent.

Mr. Arthur T. Doud, Junior member of the Society and formerly Engineer with Gunn, Richards & Co., 43 Exchange Place, New York, has accepted a position as manager of the Walker M. Levett Co., at 464 Tenth Ave., New York.

Mr. Frank E. Eberhardt is at present Treasurer of the Newark Gear Cutting Machine Co., Newark, N. J. The former firm name was Eberhardt Bros. Machine Co.

Mr. Horatio A. Foster, formerly Resident Engineer with Mr. L. B. Stillwell, Consulting Engineer, Continental Building, Baltimore, Md., is now located in a similar position at 100 Broadway, New York.

Mr. Harry A. Gillis is the Junior partner of the firm of Fowler, Hardesty & Gillis, Consulting Engineers, with an office in the Home Life Building, Washington, D. C.

Mr. Wm. B. Goetner, formerly with the Virginia-Carolina Chemical Company, Richmond, Va., is now located at Willow Grove, Pa.

Mr. Augustus Hanson has accepted a position with the Nevada-California Power Co., Tonopah, Nev.

Mr. C. H. Helvey, formerly of Hamilton, O., has accepted a position with the Power Equipment Company, Contracting Engineer at 50 Church St., New York.

Mr. Howard M. Ingham, formerly with the Avram-Leet Engineering Co., of New York, is at present Manager of the Bliss-Griffiths Construction Co., 225 Fifth Ave., New York.

Mr. Edward K. Junghans, former Chief Engineer of the Bethlehem Sukker Fabrik, St. Croix, D. W. I., has been made Superintendent of the Factory and Chief Engineer of The Porvenir Sugar Co. at San Pedro de Macoris, Santa Domingo.

Mr. James A. Kinkead has severed his connection as Engineer of Tests of the American Locomotive Company at Schenectady, N. Y., to assume the duties of Manager of Sales of The Parkesburg Iron Co., Singer Building, New York.

Mr. John G. Lepper of E. P. Linch Manufacturing Co., Waterbury, Conn., has been transferred to the Philadelphia branch of that company with office in the Real Estate Trust Bldg., Broad and Chestnut Sts.

Mr. Elihu R. Lyman, formerly with the Ames Iron Works, Boston, Mass., has recently accepted a position as Mechanical Engineer with the United States Heater Co., Detroit, Mich.

Prof. L. B. Marks, Assistant Professor, Harvard University, and who has recently had an office as Consulting Engineer at 220 Broadway, and Mr. J. E. Woodwell, formerly Inspector of Electric Light Plants, Treasury Dept., Washington, D. C., have opened a consulting engineering office together in the Terminal Building, 41st Street and Park Ave., New York.

Mr. Geo. B. Massey, formerly with the Bucyrus Company at South Milwaukee, Wis., has been transferred to the New York office at 50 Church St., and appointed Resident Engineer.

Mr. J. G. Matthews has severed his connection with the Cleveland Twist Drill Company, and accepted a position as instructor in the Mechanical Drawing Department of the Cleveland Technical High School, Oberlin, O.

Mr. James A. Moyer, recently connected with Westinghouse, Church, Kerr & Co., as Statistical Engineer, is now associated with the University of Michigan, Ann Arbor, as Assistant Professor of Mechanical Engineering.

Prof. Charles R. Richards, formerly Director, Department of Manual Training, Teachers' College, Columbia University, has been appointed Director of Cooper Union for the Advancement of Science and Art, New York.

Mr. Jacob D. Schakel, recently connected with the Otis-Fenson Elevator Co., Ltd., of Canada, is now located with the Otis Elevator Co. of Philadelphia, Pa.

Mr. Earl F. Scott, Consulting Engineer, until recently in New Orleans, La., is now associated with the General Fire Extinguisher Company, 276 Marietta St., Atlanta, Ga., as Mechanical Engineer.

Mr. William H. Smead has severed his connection with the General Fire Extinguisher Co., Atlanta, Ga., and is now Mechanical Engineer with the Proximity Manufacturing Co.'s Mills, Greensboro, N. C.

Mr. Parkin T. Sowden has accepted a position as Superintendent with the Standard Silver Co., Toronto, Canada.

Mr. Edward G. Thomas, who has recently had an engineering office at 88 Broad Street, Boston, Mass., is now connected with the Ariston Marble Co., Brooklyn, N. Y., in the capacity of Superintendent.

THE JOURNAL

OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

VOL. 30 NOVEMBER 1908 NUMBER 10

THE monthly meeting for November will be held in the Engineering Societies Building on the evening of November 10. A lecture will be given upon The High Powered Rifle and its Ammunition, by Franklin Phillips, president of the Hewes and Phillips Iron Works, Newark, N. J., and Inspector of Small Arms Practice, National Guard of New Jersey.

For a long period following the famous matches at Creedmoor, long distance rifle shooting by American marksmen was to a considerable extent a lost art and when American teams participated in international matches they failed to win. Finally a number of interested riflemen began a scientific study of the causes of inaccuracy in shooting and investigations were conducted in which means were adopted for making accurate comparisons of results at target trials.

Mr. Phillips will trace the development of the rifle and its ammunition, explaining details of construction, and many lantern slides will be exhibited showing these details as well as the actual use of the rifle by experts. The art of rifle shooting at the present time is comprised in hitting fast rather than shooting fast. An occasional erratic shot through some defect in gun, bullet or powder is not to be tolerated. The lecturer will show how some of these defects have been overcome.

ANNUAL MEETING

TO BE HELD IN NEW YORK, DECEMBER 1-4

In this number of The Journal are published four additional papers for the annual meeting, making the published list to date as follows:

The Engineer and The People, by Morris Llewellyn Cooke.

Liquid Tachometers, by Amasa Trowbridge.

A Method of Obtaining Ratios of Specific Heats of Vapors, by A. R. Dodge.

An Averaging Instrument for Polar Diagrams, by Prof. W. F. Durand.

The Slipping Point of Rolled Boiler Tube Joints, by Prof. O. P. Hood and Prof. G. L. Christensen.

Some Possibilities of the Gasolene Turbine, by Prof. Frank C. Wagner.

Salt Manufacture, by George B. Willcox.

Efficiency Tests of Milling Cutters and Milling Machines, by A. L. DeLeeuw.

Physical Properties of Carbonic Acid and Conditions of its Economic Storage for Transportation, by Prof. R. T. Stewart.

The Total Heat of Saturated Steam, by Dr. H. N. Davis

Industrial Photography, by S. Ashton Hand.

It is expected that by the time this number of The Journal is issued all the papers for the annual meeting will be in hand for the consideration of the Meetings Committee; and as far as possible the balance of the papers will be published in the Mid-November number in order to give members time to prepare their discussions before the meeting.

MACHINE SHOP PAPERS

In this number are two papers for the annual meeting of unusual importance to builders of machinery: one by Mr. DeLeeuw upon tests conducted by him preliminary to the design of a new series of milling machines, and the other by Mr. Hand upon Industrial Photography. Besides these there will be other contributions of extraordinary interest upon cutting tools and recent developments in spur

gearing, the whole comprising a list of strong papers bearing directly on the design and construction of machinery, with due regard for the commercial as well as the purely technical sides. While the work of the mechanical engineer has broadened out into many fields, such subjects are peculiarly within his province. However diversified his work in individual instances, he is bound to be interested in improved methods for the production of machinery. These papers will be grouped and used for a session upon machine shop practice, and as the papers will deal almost entirely with new developments, no member can afford to miss this session, if he is within reaching distance of New York at the time of the annual meeting.

OTHER PAPERS

While the subjects for the balance of the papers cannot be definitely announced at this time, there are several papers under consideration that will attract very wide attention and will be remarkable additions to the store of printed information upon engineering topics. The complete program will be published in the next number with full information about these, as well as upon the entertainment to be provided by the local membership for the visiting members and their guests.

AERONAUTICS

On Wednesday morning, December 2, there will be the paper upon Aeronautics by Major Squier, Acting Chief Signal Officer, Washington, D. C., about which particulars have already been given, and we desire to impress upon members the fact that this paper, together with the popular lecture upon the same subject by Lieutenant Lahm, to be given Wednesday evening, will form the most important and striking presentation of aeronautics that has been given in this country.

This is the first time that aeronautics has been considered by any of the national engineering societies of America. It is only now that the science of flying by mechanical means has been developed to the point where it would be thought advisable to place a record of the achievement and a statement of problems involved in the publications of an American engineering society. In taking this important step, the Society is to be congratulated on having its material from so authoritative a source and presented by engineers so unbiased

and able as the two officers who are to appear before it at the December meeting. The data, photographs and drawings placed at the disposal of the Society for these papers are obtained through the courtesy of the War Department, where every bit of obtainable information upon aeronautics is on file, not only in respect to the work accomplished by the government and individuals in this country, but by governments and individuals abroad.

RAILROAD TRANSPORTATION NOTICE

Special concessions have been secured for members and guests attending the Annual Meeting in New York, December 1–4, 1908. Read carefully the following details.

The special rate of a fare and three-fifths for the round trip, on the certificate plan, is granted when the regular fare is 75 cents and upwards, from territory specified below.

a Buy your ticket at full fare for the going journey, between November 27 and December 3 inclusive. At the same time request a certificate, *not a receipt.* This ticket and certificate should be secured at least half an hour before the departure of the train.

b Certificates are not kept at all stations. Find out from your station agent whether he has certificates and through tickets. If not, he will tell you the nearest station where they can be obtained. Buy a local ticket to that point, and there get your certificate and through ticket.

c On arrival at the meeting, present your certificate to Mr. S. Edgar Whitaker at the Headquarters. A fee of 25 cents will be collected for each certificate validated. No certificate can be validated after December 4.

d An agent of the Trunk Line Association will validate certificates December 2, 3 and 4. No refund of fare will be made on account of failure to have certificate validated.

e One hundred certificates must be presented for validation before the plan is operative. This makes it important to ask for certificate, and to turn it in at Headquarters. Even though you may not use it this will help others to secure the reduced rate.

f If certificate is validated, a return ticket to destination can be purchased, up to December 8, on the same route over which the purchaser came, at three-fifths the rate.

This special rate is granted only for the following:

The Trunk Line Association:

All of New York east of a line running from Buffalo to Sal-

amanca, all of Pennsylvania east of the Ohio River, all of New Jersey, Delaware and Maryland; also that portion of West Virginia and Virginia north of a line running through Huntington, Charleston, White Sulphur Springs, Charlottesville and Washington, D. C.

The Central Passenger Association:

The portion of Illinois south of a line from Chicago through Peoria to Keokuk and east of the Mississippi River, the States of Indiana, and Ohio, the portion of Pennsylvania and New York north and west of the Ohio River, Salamanca and Buffalo, and that portion of Michigan between Lakes Michigan and Huron.

MEETING OF THE COUNCIL

A regular meeting of the Council was held on the afternoon of Tuesday, October 13, in the Council room of the Society, 29 West 39th Street, New York.

The meeting was called to order at 3.30 p.m., with Vice-President P. W. Gates in the chair. There were present: Messrs. P. W. Gates, John W. Lieb, Jr., Fred J. Miller, Wm. H. Wiley, the Secretary, and Past-Presidents C. W. Hunt, Ambrose Swasey and Fred W. Taylor.

MEMBERSHIP

The Secretary reported the following deaths: H. W. Cake, S. B. Cox, Fred N. Fowler, F. A. Johnson, F. N. Kleinhans, F. X. McGowan, Wm. Anson Pearson, E. F. Schaefer, Jos. Stone, Harris Tabor.

The Council directed that the Secretary send to the estate of a deceased member a marked copy of The Journal containing the memorial notice of such member.

RESIGNATIONS

The following resignations were accepted by the Council: Chas. C. King, E. B. Guthrie, E. E. Hanna.

CANDIDATES FOR MEMBERSHIP

The Candidates shown by the Professional Service Sheet of September, 1908, were approved and the names were ordered submitted to the voting membership. The ballot will close November 25, 1908.

FINANCES

The balance of unexpended appropriations, $2700.99, upon the recommendation of the Finance Committee, was ordered cancelled.

Budget 1908–1909: The consideration of the budget of 1908–1909 was deferred until the next meeting. The Council ordered trans-

ferred to Profit and Loss $830.16 unexpended appropriations for the year 1906–1907.

COMMITTEES

Conservation Committee:—The Council approved the appointment of the Committee on Conservation of the Natural Resources of the Country, the personnel of which is as follows, George F. Swain, *Chairman*, L. D. Burlingame, Chas Whiting Baker, M. L. Holman, Calvin W. Rice, and requested that the Committee outline to the Council before the next meeting, the scope of the work which they recommend that the Society undertake.

Library:—The Council approved the recommendation that permission be granted the Secretary, upon the recommendation of the Librarian and the Chairman of the Library Committee, to dispose of the duplicate periodicals and books secured by virtue of the joint operation of the three libraries, the proceeds of the sale to be credited to the appropriation for the Library Committee.

Publication: The Publication Committee reported Volume 29 on the press and Volume 30 well advanced.

STANDARDS

International Standard Pipe Threads: The Secretary reported to the Council the recommendations of the special committee, consisting of Messrs. E. M. Herr, *Chairman*, George M. Bond, Wm. J. Baldwin and Stanley G. Flagg, appointed to report on an international standard for pipe threads and fittings.

The Secretary was requested to give the substance of this report to the American Gas Institute which has invited the Society to assist in preparing an argument in favor of the Briggs Standard to be presented at the conference in Paris, January 1, 1909.

Standard Tests of Refrigerating Machines: The Secretary reported a communication from the chairman of the committee of the Society appointed to report on a standard tonnage basis for refrigeration, recommending that the committee prepare a joint report with the committee of the American Society of Refrigerating Engineers on Standardization of Tests of Refrigerating Machines. The recommendation was approved.

Code for Conducting Steam Boiler Trials: The matter was referred to a special committee to consist of Mr. John W. Lieb, Jr., and Mr. Fred W. Taylor.

REPLICA OF THE THURSTON MEMORIAL

The Secretary was most happy to receive from the chairman of the committee of the alumni of Sibley College, Cornell University, permission to have a replica made of the tablet of Prof. R. H. Thurston, recently erected at Cornell. The sculptor of the Memorial, Mr. H. A. McNeil, has consented to make the tablet.

A committee was formed several years ago to secure funds for a memorial in bronze of Professor Thurston. The subscriptions received at that time are almost sufficient for the tablet.

The Council thereupon voted to erect the tablet in the building of the Engineering societies, and appointed the following committee to supervise the work: Dr. Alex. C. Humphreys, *Chairman,* Messrs. Charles Wallace Hunt and Fred J. Miller.

A photograph of the tablet was published in the October 1 issue of The Journal.

SIR BENJAMIN BAKER MEMORIAL

The Secretary reported having sent to the Institute of Civil Engineers of Great Britain a subscription of $155 from members of the Council toward the memorial window to Sir Benjamin Baker, Honorary Member of the Society, to be erected in Westminster Abbey.

COURTESIES TO OTHER SOCIETIES

The Council voted to join with the American Society of Refrigerating Engineers in tendering the use of the building of the Engineering Societies in the event that the International Congress of Refrigerating Industries should hold its Congress in this building next year.

The Secretary reported that the Society had extended through Honorary Councillor Mr. Ambrose Swasey the courtesies of the rooms and library of the Society to the following engineering institutions in Great Britain, and that most cordial acknowledgments had been received: The Institution of Electrical Engineers, The Institution of Mechanical Engineers, The Institution of Civil Engineers, the Iron and Steel Institute.

GENERAL NOTES

A MEMBER OF THE SOCIETY HONORED

King Edward VII has recently conferred Knighthood upon Mr. Robert A. Hadfield, member of the Society and chairman and managing director of the Hadfield Co., Sheffield, England, in recognition of his valuable services in the field of industrial and scientific progress through his researches and experiments in metallurgy, and his invention of manganese steel.

At the meeting of the Iron and Steel Institute held in New York, Oct. 3, 1890, Mr. Hadfield presented a paper on "Aluminum Steel" after which the President, Sir James Kitson, now Lord Airedale, proposed that the thanks of the meeting be tendered him for his continued generosity in giving to the Institute the results of his valuable research and labor, and nominated him for a seat in the council. The proposal and nomination were unanimously voted.

He has also received, on different occasions, honors from the following scientific societies: From The Institution of Civil Engineers in 1888, the Telford gold medal and premium; and in 1899 the George Stephenson gold medal and premium. In recognition of his researches on the subject of manganese steel the Franklin Institute of Philadelphia presented him in 1891 with the John Scott legacy medal and premium; La Société d'Encouragement pour l'Industrie Nationale presented him with a gold medal in 1890 and another in 1895. In 1903 Sir Robert received the Howard Prize and premium awarded by the Institution of Civil Engineers quinquennially. Former recipients of this prize were Sir Henry Bessemer, Sir William Siemens, and Sir Lowthian Bell; The Iron and Steel Institutute awarded him the Bessemer gold medal in 1904.

Sir Robert's contributions to the science of metallurgy are: "Manganese in its Application to Metallurgy" (manganese steel); "Some Newly Discovered Properties of Iron and Manganese;" "Manganese Steel;" "Alloys of Iron and Silicon;" "Alloys of Iron and Aluminum;" "Alloys of Iron and Tungsten."

A GIFT TO THE SOCIETY

Mr. Henry Harrison Suplee, Chairman of the Library Committee of this Society, has made a gift to the library of sixty volumes of valuable technical books. A complete list is published in this issue of The Journal under Acquisitions to the Library. The thanks of the Society are due to Mr. Suplee for his liberality in adding to the reference resources of the library.

NEEDS OF THE LIBRARY

The Library needs several volumes of periodicals to complete its valuable sets and the attention of the membership is called to the list published among the advertising pages in this issue of The Journal. The Secretary will be very glad to hear from any member who can provide any of the books there mentioned, either by gift, purchase or exchange, and by helping to complete these sets a valuable service will be rendered to the Library and therefore to the Society.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

The American Institute of Electrical Engineers held a meeting on Friday, Oct. 9, in the Engineering Societies Building at which a paper entitled High Potential Underground Transmission was presented by Messrs. P. Junkersfeld and E. O. Schweitzer. The paper described a 9000 volt and a 20 000 volt 3-phase cable main of the Commonwealth Edison Co., of Chicago. It was discussed by Messrs. Chas. H. Merz (London, England), E. J. Berg, Wallace Clark and others.

THE AMERICAN INSTITUTE OF MINING ENGINEERS

The American Institute of Mining Engineers held their annual meeting Oct. 8, in Chattanooga, Tenn., with headquarters at Hotel Patten. Professional sessions were held Thursday, Friday and Saturday, after which those attending the convention visited the mines and furnaces of the Roane Iron Co., at Rockwood, Tenn., the mines at Copper Hill and Ducktown, and the mines, smelters and sulphuric acid plants of the Tennessee Copper Co. and the Ducktown Sulphur, Copper and Iron Co., at Knoxville. Before returning home several went to Birmingham to inspect the mines there.

THE AMERICAN SOCIETY OF CIVIL ENGINEERS

The American Society of Civil Engineers held a meeting in New York, Oct. 7, at which a paper was presented by Mr. O. F. Liford, Jr., of the Westinghouse, Church Kerr & Co., on Catenary Trolley Construction. The paper was a description of the construction employed in the electrification of the Denver & International Railroad, running from Denver to Boulder, Colo.

THE ILLUMINATING ENGINEERING SOCIETY

The Illuminating Engineering Society held their second annual convention in Philadelphia, Oct. 5 and 6. An address was made by the President, Dr. Louis Bell of Boston, in which he emphasized the practical side of street lighting, advocating greater diffusion, decreased brilliancy, better distribution and more light, and a number of papers were read relating to the subject of illumination.

The committee on standards presented a report of the progress toward securing an "international candle" or unit of light strength. The appointment of a joint committee by the American Institute of Electrical Engineers, American Gas Institute and the Illuminating Engineering Society was reported. The resolutions adopted by this joint committee were in favor of a unit of candle power which would be a compromise between the units used in gas and electric lamp photometry in this country, as being close to the mean value of the units used in the national laboratories in this country, England and France. They advocate the use of the unit in this country during the intervals required for the consummation of international action that would be 2 per cent less than that now used by the bureau of standards.

INTERNATIONAL CONGRESS OF REFRIGERATING INDUSTRIES

The First International Congress of Refrigerating Industries was held in Paris, France, October 5 to 10. The University of Paris generously placed the Sorbonne at the service of the convention, and the sessions were held in its auditorium.

The congress was under the official patronage of the Republic. M. Emile Loubet, ex-president of the French Republic, and M. de Freycinet, member of the Institute, senator and ex-minister, were the chairmen of the Committee of Honor, which was composed of about 50 ex-ministers, members of the Institute, governors-general of colonies, officials of the administrations, presidents of important press associations, presidents of large scientific, agricultural, industrial and commercial societies, presidents of chambers of commerce, presidents of colleges and presidents of large transportation companies.

M. André Lebon, ex-minister of commerce, ex-minister of colonies, was the president of the executive committee of the congress, and M. Touchard, the distinguished Secretary-General of Credit Foncier of France, treasurer.

Representatives were delegated to the congress from L'Académie des Sciences, L'Académie de Médecin, Les Conseils Généraux, institutions of learning, scientific, industrial, agricultural and commercial associations of France and other countries.

The members of the Society participating were Mr. John E. Starr, Vice-President of the American Committee of the Congress, and Mr. Gardner T. Voorhees appointed Honorary Vice-President of the Society for the occasion, and papers were contributed by the following members: Messrs. John E. Starr, Gardner T. Voorhees, D. S. Jacobus.

In addition, the following countries sent special delegates: Austria, Bavaria, Denmark, Hungary, Italy, the Grand Duchy of Luxembourg, Norway, Russia, the Netherlands, Servia, Switzerland, Turkey; America; the Argentine Republic, Brazil, the United States, Paraguay, Uruguay; Asia and Oceanica; China, Japan, Queensland, Tas-

mania, Victoria, Australia, New Zealand. The United States was officially represented by delegates appointed by the Secretary of State and the Secretary of Agriculture.

The first section, of which M. D'Arsonval, member of the Institute, and professor at the College de France, was president, considered Low Temperatures and their General Effects. The following papers were read:

Effects of Low Temperatures and their Action, Physical, Chemical and Biological, by M. Georges Claude; General Hygiene, showing advantages and disadvantages of refrigeration in public and private places, by Dr. Bordas; Alimentary Hygiene, treating of the dietetic value of chilled and frozen food, by Dr. Navarre.

The second section, of which M. H. Leaute, member of the Institute, and professor of the École Polytechnique, was president, discussed Refrigerating Appliances. The following papers were read:

Refrigerating Machinery, Standardization of Refrigerating Measures and Employment of Dry and Wet Refrigeration, by M. A. Barrier; Standardization of Refrigerating Measures, by D. S. Jacobus; The Construction of Cold Stores, Insulating Materials, Refrigeration in Magazines for Explosives and Refrigeration in Packing Houses, by Dr. Imbeaux.

The third section, of which M. A. Gautier, member of the Institute, and president of the Académie de Médecin, was president, considered The Application of Refrigeration to Food. The following papers were read:

Changes in Produce while in Cold Storage Chambers, by Dr. Regnard; Colonial Produce Capable of Benefiting by Refrigeration, by M. J. Chailley, Artificial Cold in the Manufacture of Butter, by M. P. Rouvier; Cold Storage Organization, by M. Maurice Quentin; Victualing of Besieged Towns and of Troops, by M. G. Chapuis; Sea Fisheries and Refrigeration, by M. H. deVarigny.

The fourth section, of which M. E. Tisserand, of the Institute, and Honorary Director of Agriculture, was president, discussed The Application of Refrigeration to Other Industries. The papers were:

Retardation and Preservation of Flowering Plants by the Application of Cold, by M. Ph. de Vilmorin; Influence of Refrigeration on the Clarification of Fermented Beverages, by M. A. Fernbach; Ice-making, by M. P. Fabry; Mines, Metallurgy, Public Works; New Industrial Applications of Refrigeration, by M. D. Saladin.

The fifth section, of which M. Levasseur, member of the Institute, and Director of the College de France, was president, considered Application of Refrigeration in Commerce and Transport. The papers were:

Progress of Trade in Perishable Produce, by M. D. Perouse; Organization of Cold Storage Transport on Railways, by M. G. de Pellerin de Latouche; Organization of Cold Storage Transport by Sea, by M. J. Dal Piaz.

The sixth section of which M. J. Cruppi, Deputy, Vice-President of the Chamber of Deputies, was president, considered Legislation. The papers were:

Laws and Regulations to be Modified, by M. J. Lauraine; The Value of Refrigeration in the Food Supply of the Poorer Classes, by M. M. Saint-Germain.

During the afternoons of the congress, excursions were made to various industrial plants about Paris among which were the plant for the manufacture of liquid air by the process discovered by M. Georges Claude, the ice factory of Villan Court, the works of La Société des Glacières, Paris, L'Institut Pasteur, the works of La Société d'Eléctricité de Paris at Saint Denis, the refrigerating plants of the packing houses of La Villette and La Conservatoire des Arts et Métiers. An excursion to Fontainebleau was a pleasant event. The foreign groups—German, English, Spanish and Italian were accompanied by a guide who spoke the language of the party.

A banquet was given as a fitting close of a very delightful event. M. André Lebon presided. It was characterized by simplicity, and *cachet de fête de famille*, remarkable where all countries and languages were represented. Delegates from all the foreign governments had the pleasure of seeing their national colors decorate the table of honor.

Several toasts were given at the close of the banquet, M. Lebon, the president, lifting his glass in honor of the kings and presidents of the countries represented. The second toast was to the hospitality of the City of Paris, and in closing M. Tellier, who may be termed the originator of the congress, was saluted. A résumé of the Refrigerating Congress was given in a word: "We have worked for something which endures. *C'est là toute la philosophie.*"

The General von Vendrich, minister of Roads and Communications of Russia, offered a toast to the City of Paris in the name of the delegates from the North and M. Samarelli, Italian Under-Secretary of State, in behalf of the delegates from the South.

M. Tellier, in a short address, thanked M. Lebon for his courteous compliments. He said in closing: "God is the power. Man can only try to reduce the effects of the terrible forces of nature."

The closing session of the congress was devoted to resolutions and

farewell addresses. M. Chéron, Sous-Secrétaire d'Etat, presided. Short addresses were made by M. Lebon, president of the congress, and by M. Chéron, followed by a scholarly and philosophical address on liquid air by M. d'Arsonval.

The next International Congress of Refrigerating Industries will be held in Vienna in 1910 and the third congress will probably be held in the United States.

The importance of the inauguration of an international congress of refrigeration cannot well be estimated. That it will have its influence upon the economic conditions of all the countries of the world cannot be doubted. It is a cause for national pride that the United States is leading the world in the development of refrigeration, and this country should take advantage of the disposition, manifested at the congress, to hold the third convention here.

The Society acknowledges the thoughtfulness of Mr. Voorhees in regularly sending reports of the Congress, from which the above was translated.

PAN-AMERICAN SCIENTIFIC CONGRESS

The first Pan-American Scientific Congress will be held in Santiago, Chile, Dec. 25, 1908, to Jan. 5, 1909, under the auspices of the government of Chile. Universities, scientific societies, Chilian and foreign corporations will be represented. Questions of interest to South, Central and North America will be discussed. The broad scope of the Congress is shown by the subjects for discussion, among which are pure and applied mathematics, physical sciences, natural, anthropological and ethnological sciences, engineering, medical science and hygiene, juridical and social sciences, the sciences of pedagogy and of philosophy, agronomy and zoötechnics. Americans who have become prominent in the field of science will represent their several countries at the Congress.

The Society, through the Secretary, has been assisting the delegation of the United States to secure the papers on engineering, to which an entire section has been devoted. The papers, prepared by men whose names will be recognized at once as carrying authority in the world of engineering, have been transmitted to the International Bureau of American Republics for translation and transmission. They are as follows:

MEMBERS OF THE SOCIETY

William H. Burr, C.E., professor of civil engineering at Columbia University, "Reinforced Concrete Construction for South America."

William Kent, A.M., M.E., "Economy of Fuel."

Charles E. Lucke, M.S., Ph.D., head of department of mechanical engineering, Columbia University, "The Value of Gas Power."

R. M. Dixon, M.E., president of The Safety Car Heating and Lighting Co., New York, "Car Lighting in North America."

William Hutton Blauvelt, M.E., M.S., consulting engineer, Semet-Solvay Co., Syracuse, N. Y., "The Use of Tertiary Coal in General Metallurgy and in the Manufacture of Coke."

Rudolph Hering, hydraulic and sanitary engineer, "The Supply of Potable Water."

NON-MEMBERS

J. F. Kemp, M.E., Sc.D., professor of geology, Columbia University, New York, "The Newer Geological Views regarding Subterranean Waters."

William J. Wilgus, chief engineer of construction and maintenance of way, and vice-president, N. Y. C. & H. R. R. R., "Plans and Gages of Inter-Continental Railways."

Frank J. Sprague, electrical engineer, "Application of Electricity to Railways."

C. O. Mailloux, consulting electrical engineer, "Terminologia Pan-Americana."

Robert Hallowell Richards, S.B., Mass. Institute of Technology, "Processes for the Concentration of Ores."

William S. Myers, M.Sc., director Chilian Nitrate Propaganda, "American Agriculture in its Relation to Chilian Nitrate."

Allen Hazen, civil engineer, "Water Supply of Cities and Towns."

R. W. Raymond, Ph.D., LL.D., secretary of the American Institute of Mining Engineers, "The Mineral Wealth of America."

Walter R. Ingalls, editor, the Engineering and Mining Journal, New York, in collaboration with Dr. R. W. Raymond, "The Mineral Wealth of America."

The Chilian government has requested the United States to send delegates, and the invitation was met in a fraternal spirit which portends well for the movement of international conciliation, now being fostered.

The following delegates were appointed by the State Department of the Government:

L. S. Rowe, *Chairman*, Hiram Bingham, Archibald Cary Coolidge, William C. Gorgas, U. S. A., W. H. Holmes, Paul S. Reinsch, *Vice-Chairman*, Bernard Moses, George M. Rommel, William R. Shepherd, William Benjamin Smith.

EDUCATIONAL COÖPERATION

The possibilities of educational coöperation between North and South America have received a scant measure of consideration in this country. Prof. L. S. Rowe, LL.D., Professor of Political Science in the University of Pennsylvania, chairman of the delegation from the United States, who may be called the missionary of our educational system in the Southern Americas has emphasized our responsibility toward the American Republics. He states that it is evident to every one who has watched the national feeling in South America that the time has come when we must view our position on this continent with a keener sense of the responsibilities which it involves, and shape our policies with a view to our future as well as our present standing among our neighbors. The South American people have a feeling of admiration for the wonderful progress of our country and a sincere desire to profit by it. This new spirit finds distinct expression in the almost universal demand for American teachers and American educational methods. Dr. Rowe gives three possible lines of activity for developing educational coöperation: First, the better preparation of American teachers for service abroad, and the cultivation on the part of the teachers of a spirit of adaptability, from which results a ready sympathy with a people whose point of view is different from our own. Second, a concerted effort to attract a larger number of South American students to our normal schools and universities. Third, the establishment of closer relations between the universities of North and South America and between investigators in various fields.

An article by Señor Augusto Vicuna of Chile, Pro-Secretary of the Committee on Organization of the Pan-American Scientific Congress is published in the August number of *Revista de Devecho, Historia y Letras,* of Buenos Aires, and is translated in the October number of the Bulletin of the International Bureau of the American Republics. It is interesting as showing the attitude of a representative citizen toward this country. He says in part:

> The Pan-American Scientific Congress will have its part in cementing, upon the basis of mutùal understanding and intellectual community, friendship with the United States—a country that for some time has drawn toward the young American Republics, not to satisfy ambitions for territorial annexation, but to offer them its aid in successfully fulfilling the duty of progress laid upon every nation aspiring to hold a place in civilization. The coming congress should give a mortal wound to the prejudices and false ideas that have kept us for nearly a century subject to an intellectual slavery in which Europe has dominated, and influenced us with its laws, customs, history and literature. While we appre-

ciate and esteem the intellectual aid which Europe proffers us, we wish, at the same time, to take an inventory of what we are receiving, in order to choose what does and refuse what does not accord with our social organizations, our customs, our traditions, and our education, which finally is the regulator of progressive capacity. It is necessary for America to develop its institutions in the light of its history, and the peculiar conditions of its social state.

To form an American mentality, to carry to the laws and to the national organism its own breath of life, to trace in the special peculiarities of each people that which is best for its moral, intellectual and material perfectionment—here is the beneficent idea which it is proposed to make central at the coming Congress. Everything tends to clear the road in order that the intelligence of the three Americas may join forces to bring to the solution of their problems a criticism, cool, independent, and free from the imposition of a foreign medium.

The once absolute supremacy of European ideas and criticisms was explicable. The enmities and jealousies which kept the people of the North and South apart—want of communication, difficulty of intellectual commerce (the precursor of material commerce)—worked so effectively that Europe was for nearly a century the school mistress who gave us her primers on political organization, her tracts on political economy, her texts on pedagogy; our speakers in enlightening public opinion leaned upon the authority of Bluntschill, John Stuart Mill, Adam Smith and others. Today all is changed. Powerful currents of cordiality circulate through the American organism. Thinking men from the Southern half of the Continent draw together, with men of the Northern half, inspired by a sincere purpose to study together the questions which concern the common country, America.

The creation of an American mentality forms a menace to no one, nor is it a formula to bring into being political alliances formed for aggressive purposes.

The Fourth Scientific Congress, The First Pan-American, will cement upon granite bases the union of the Americas, not to flaunt the sinister trappings of armed peace, but to give an example to the world of the subjection of prejudice and enmity to the cause of human progress.

PERSONALS

Mr. Francis W. Scarborough has opened an office under the corporate name of Scarborough & Howell, Inc., Richmond, Va., for the practice of architecture and engineering.

Prof. Edward Robinson of the University of Vermont, has obtained a year's leave of absence from the University. During this time he will visit the different universities in this country and abroad to note what they are doing along mechanical engineering lines.

Mr. Frank G. Bolles, formerly with the International Specialties Co., is now connected with Tungstolier Co., New York.

Mr. James H. MacLauchlin is no longer connected with the Cement Engineering & Construction Co., Saugerties, N. Y. He has accepted a position as Engineer with the American Cement Engineering Co. of 315 Fifth Avenue, New York.

Mr. William L. Caniff, who was connected with the United Engineering and Contracting Co., of New York, as master mechanic, has accepted a position with the T. A. Gillespie Co., High Falls, N. Y., in the same capacity on the Rondout Siphon tunnel.

Mr. Burdett Loomis, Jr., former president of the Loring B. Hall Co., Marlboro, Mass., is at present sales manager of Power & Mining Machinery Co. of New York, with offices in the Connecticut Mutual Building, Hartford, Conn.

Prof. C. C. Major, formerly assistant professor of engineering drawing of Ohio State University, has been appointed associate professor of mechanical engineering at the Iowa State College, Ames, Ia.

Mr. W. P. Dallett has been placed in charge of the branch of the Riverside Engine Co. which has just been organized and located at 49 N. 7th St., Philadelphia, Pa.

The corporate name of the Dodge Coal Storage Co. has been changed to, The J. M. Dodge Co. James M. Dodge, Chairman of the Link-Belt Co., is president.

Mr. George A. Buvinger, formerly connected with the Dayton Hydraulic Machinery Co., Dayton, as Chief Draftsman, is at present Hydraulic Engineer with the D'Olier Engineering Co., 119–121 So. Eleventh St., Philadelphia.

Mr. I. Woldenberg has left for Budapest, Austria-Hungary, where he is to represent the Ingersoll-Rand Co. He has been Chief Draftsman for this Company in New York.

Mr. Ernest L. Ohle has resigned his position as professor of steam engineering and head of the department of mechanical engineering at the State University of Iowa, to accept the position of professor of mechanical engineering at Washington University.

Mr. Horatio S. McDewell, who was assistant in experimental and engineering thermodynamics at Harvard University, is now with the Allis-Chalmers Co., West Allis, Wis. He was granted the degree of Master in Mechanical Engineering by Harvard University last June.

Mr. Carleton A. Read, formerly professor of mechanical engineering at New Hampshire College, has accepted the position of professor of steam engineering at Worcester Polytechnic Institute.

Mr. John R. Morgan, recently with the Morgan Engineering Co. in the capacity of mechanical engineer, is general manager of the Calumet Engineering Works Harvey, Ill.

Mr. J. Henry Sirich, Jr., recent turbine engineer with the Westinghouse Machine Co., has been engaged by the Bethlehem Steel Co. in the power department.

Mr. Charles S. Hamner, formerly located at 50 Church St., is now a member of the firm of Hamner & Moody, with offices at 25 Broad St., New York.

Mr. Edward W. Lindquist, Chief Draftsman Mining Department of the Allis-Chalmers Co., Milwaukee, Wis. has been transferred to the San Francisco, Cal., branch of that company.

Prof. W. A. Richards, recently connected with the University of Pennsylvania as teacher of hydraulics and materials testing, is with the University High School, connected with the Chicago University, and has charge of the foundry and forge departments.

Prof. Robert C. H. Heck, formerly professor of experimental engineering at Lehigh University, Bethlehem, Pa., has been elected by the board of trustees of Rutgers College, New Brunswick, N. J., to take charge of the recently established department of mechanical engineering. Civil engineering has been a department of Rutgers for many years, and the development of the engineering school has been marked by the establishment of a department of electrical engineering, by the erection of a new engineering building, now almost completed, in which the three engineering departments will be located, and by the installation, this year, of the department of mechanical engineering under Professor Heck's direction.

The Society learns with deep regret of the death of Mr. Bennett H. Brough, Secretary of The Iron and Steel Institute (London, England) which occurred at Newcastle-on-Tyne, Saturday, October 3. The funeral was held at the family residence, Subitor Hill, on Friday, October 9, at noon.

Prof. H. Wade Hibbard, professor of mechanical engineering of railways, Sibley College, Cornell University, has been selected by the board of curators to the chair of mechanical engineering in the University of Missouri. Professor Hibbard succeeds Prof. A. M. Greene, Jr., also a member of the Society, who resigned to accept a similar position at Rensselaer Polytechnic Institute.

Professor Charles H. Benjamin, member of the Society, recently appointed Dean of Purdue University to succeed Dean Goss, received from the Case School of Applied Science the honorary degree of Doctor of Engineering at their Commencement last June. Dr. Benjamin was professor of mechanical engineering at Case School before accepting the appointment at Purdue.

The degree of Doctor of Science was conferred by Stevens Institute of Technology upon Dr. Henry Smith Pritchett, President of the Carnegie Foundation for the Advancement of Teaching, at the last Commencement.

Dartmouth College conferred on C. J. H. Woodbury, at its last Commencement, the degree of Doctor of Science, this being the second time that he has received the same degree. The first was from Union College, New York, in 1906.

Francis W. Hoadley, for many years assistant to the Secretary of this Society, has recently been elected secretary and treasurer of the Cassier Magazine Co., New York.

Mr. F. E. Kirby, member of the Society, received at the last commencement the first degree of Doctor of Engineering conferred by the University of Michigan.

NECROLOGY

FRANK B. KLEINHANS

Frank B. Kleinhans was born at Easton, Pa., August 20, 1874, and died in Pittsburg, Pa., September 1, 1908. He was educated in the high school of Easton, and at Lafayette College, graduating in 1897 with the degree of Electrical Engineer. In 1900 he was given the degree of Master of Science. In 1897 he entered the employ of the Baldwin Locomotive Works, Philadelphia, where he remained for three years. In 1900 he entered the employ of Bement, Niles and Company, Philadelphia, as designer; in 1902 he became Chief Draftsman of Lodge & Shipley Machine Tool Company, Cincinnati, resigning the position in 1903 to become Chief Engineer of the Fischer Foundry and Machine Company of Pittsburg; he left this company in 1906 for the United Engineering Company, with which firm he was connected until his death.

He wrote extensively for the technical journals and was the author of a book on Boiler Construction. At the time of his death, he was writing a series of articles for The Boiler Maker on the subject of Flanging Boiler Plates.

He was a member of St. John's Lodge, No. 219, Free and Accepted Masons, Pittsburg, Pa.

FRANCIS X. McGOWAN

Francis X. McGowan, whose death resulted from a railroad accident on September 4, 1908, was born in Lawrence, Mass., February 11, 1877. He attended the public schools of that city, graduating from the high school in 1895, after which he entered the Massachusetts Institute of Technology, graduating from the mechanical course with the class of 1900. After graduation he entered the power division of the Western Electric Company, New York, and was later transferred to the engineering sales department. He remained in the employ of this firm to the time of his death.

Mr. McGowan was a member of the National Geographical Society and became a Junior member of this Society in 1902.

HARRY FRANKLIN GLENN

Harry Franklin Glenn was born at Holmesburg, Philadelphia, Pa., in 1848 and was educated in the Central High School of Philadelphia. For some years he was employed in the dry goods business in that city. In 1870, he went to Berwick, Pa., where he entered the employ of the Jackson & Woodin Manufacturing Company, car builders, holding successively the positions of Clerk, Superintendent of Rolling Mill, Treasurer, Secretary, General Superintendent and General Manager. Upon the formation of the American Car and Foundry Company in 1899, he became Assistant District Manager of the Berwick Plant and was later made Consulting Engineer of the Eastern Division of the same company. He was the oldest official in point of service at this industrial plant, having served thirty-eight years.

Mr. Glenn became a member of this Society in 1894. He died at Berwick, Pa., September 11, 1908.

WILLIAM HOLLOWAY BAILEY

Mr. William Holloway Bailey died October 4, 1908, at his residence, No. 200 West 57th Street, New York, in his seventy-fifth year. He was born in Boston, Mass., May 26, 1834. He was the pioneer of the brass and copper tube industry in this country and had been connected with the American Tube Works of Boston for over fifty-eight years and for the past fifty years was the New York representative of that company. He was the oldest member of the first panel of the sheriff's jury for the County of New York, and was a member of the Union League Club for over forty years. Other organizations with which he was connected were the Engineers Club, Downtown Association, Society of Naval Architects and Marine Engineers, New York Yacht Club, Geographical Society, Metropolitan Museum of Art, Museum of Natural History and the Academy of Design.

THE JOURNAL

OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

VOL. 30 MID-NOVEMBER 1908 NUMBER 11

THE ANNUAL MEETING

The Twenty-ninth Annual Meeting of the Society will be held in the Engineering Societies Building, 29 West 39th Street, New York, December 1–4.

That the professional and social opportunities afforded by these meetings are being realized by the members is shown by the constantly increasing attendance. Five years ago at the Annual Meeting there were 474 members and guests present; last year, notwithstanding the general unsettled financial conditions, there were 1232 in attendance, which shows an increase, in the past five years, in round numbers of 750.

The professional opportunities are not confined to the sessions, where the presentation of papers and discussions takes place. The many points of engineering interest in the vicinity of New York; the large and efficiently operated power plants; the tunnels—subterranean and sub-aqueous, the latest objects of engineering achievement; the construction work constantly in operation, among which are the tallest structures in the world; all hold out valuable possibilities for investigation. Parties are arranged to visit representative works, and smaller parties will be made up upon request.

The entertainment of members and guests is one of the most important features of the convention. The presence of the ladies is especially desired at all of the evening entertainments. On the evening of

the opening session, after the presidential address, an informal reception will be held in the auditorium, which will afford the very pleasant opportunity of meeting old friends from all parts of the country, and making new. On Wednesday evening, Aeronautics, in which all the world is taking a lively interest, aroused by the recent successful demonstrations of dirigible balloons and the heavier-than-air aeroplane of the Wright Brothers, will be the subject of a non-technical lecture by Lieut. Frank P. Lahm, of the U. S. Signal Service. Moving pictures of the aeroplane in flight will be thrown on the screen, and a description of its working principles given. On Thursday evening the Annual Reception, which has always proved a very pleasant event, will be held. The members and guests will be received by the President, the President-elect and other officials of the Society, and ladies.

Indications point to the most successful meeting yet held by the Society. The attendance will doubtless exceed that of last year, and the Meetings Committee aim to have every phase of the convention more interesting and entertaining than at any previous meeting.

Six professional sessions will be held, two of them simultaneously with other sessions. There are several papers on miscellaneous subjects of pertinent interest, and an entire session will be devoted to the problems and development of gas power; at another session steam and power plant papers will be considered; and machine shop practice and experimental data will each have a separate session. The papers to be presented contain a great deal that is valuable, and the discussions will add much to the contributions, and to the interest of the sessions.

HEADQUARTERS

The Headquarters will be established in the foyer on the first floor of the Engineering Societies Building. Members and guests are requested to register immediately upon arrival, and receive a badge and program. Railroad certificates should be presented at that time for validation. The Headquarters and general arrangements will be in charge of Mr. S. Edgar Whitaker, Office Manager, Badge No. 6.

HOTEL ACCOMMODATIONS

It is not possible for the Secretary to undertake to reserve hotel accommodations for the visiting members. They are asked to communicate directly with the hotel at which they wish to stop.

THE MEETINGS COMMITTEE

The Meetings Committee is in charge of the convention. It is composed of Messrs. Charles Whiting Baker, *Chairman;* Willis E. Hall, Wm. H. Bryan, L. R. Pomeroy, and Charles Edward Lucke.

ENTERTAINMENT PROGRAM

A separate program outlining the social entertainments, excursions, etc., for both members and ladies, will be distributed at the meeting.

BADGE NUMBERS

The officers of the Society and the officials of the meeting will be designated by the following badge numbers:

No. 1480	Mr. M. L. Holman, *President*	
No. 3387	Hon. Wm. H. Wiley, *Treasurer*	
No. 1566	Prof. F. R. Hutton, *Honorary Secretary*	
No. 445	Mr. A. W. Burchard, *Chairman Finance Committee*	
No. 2594	Mr. Calvin W. Rice, *Secretary*	
No. 1077	Mr. Lester G. French, *Editor*	
No. 6	Mr. S. Edgar Whitaker, *Office Manager*	
No. 2911	Mr. Jesse M. Smith, *Nominee for President*	
No. 139	Mr. C. W. Baker, *Chairman*	*Meetings Committee*
No. 1267	Mr. W. E. Hall	*Meetings Committee*
No. 425	Mr. W. H. Bryan	*Meetings Committee*
No. 2475	Mr. L. R. Pomeroy	*Meetings Committee*
No. 1945	Prof. C. E. Lucke	*Meetings Committee*
No. 1477	Mr. H. F. Holloway, *Chairman Reception Committee*	

MEMBERS REGISTER

Two editions of the printed Members Register will be issued. The first will include the names of those registered before 9 p.m. Tuesday, and will be distributed at the morning session on Wednesday. The second edition will contain the names of those registered before noon on Thursday. It will be distributed at the reception on Thursday evening.

PROGRAM OF THE NEW YORK MEETING

OPENING SESSION

Tuesday, December 1, 8.45 p.m., Main Auditorium

The President's Address

The Conservation Idea as Applied to The American Society of Mechanical Engineers, M. L. Holman.

SOCIAL REUNION

The reading of the President's address will be followed by a social gathering at which ladies will be especially welcome.

PROFESSIONAL SESSION

Wednesday, December 2, 9.30 a.m., Main Auditorium

Annual business meeting. Reports of the Council, Tellers, and Standing and Special Committees. New business may be presented at this session.

The Engineer and the People, Morris Llewellyn Cooke.

Aeronautics, Major Geo. O. Squier, Acting Chief Signal Officer, U. S. A.

This will be the first presentation of the subject of aeronautics before a national engineering society in America. By reason of his connection with the Signal Service, Major Squier has had an opportunity to observe at close range the construction, equipment and principles of operation of heavier-than-air machines and dirigible balloons. The material upon aviation on file at the War Department, including the data sent in by the attachés in different countries, is the most complete in this country, and has been at the disposal of Major Squier for the preparation of his paper.

Luncheon will be served at 1 p.m. on the fifth floor of the building to members and guests.

PROFESSIONAL SESSION

Wednesday, December 2, 2 p.m., Main Auditorium

STEAM AND POWER PLANT PAPERS

A Method of Obtaining Ratios of Specific Heat of Vapors, A. R. Dodge.

The Total Heat of Saturated Steam, Dr. Harvey N. Davis.

Fuel Economy Tests at a Large Oil Burning Electric Plant, C. R. Weymouth.

Unnecessary Losses in Firing Fuel Oil, C. R. Weymouth.

LECTURE

Wednesday, 8.15 p.m., Main Auditorium

Aeronautics, Lieut. Frank P. Lahm, of the Signal Corps U. S. A., a member of the Aeronautical Board.

This will be an illustrated lecture of interest to every member as well as to the ladies. Lieutenant Lahm has for many years experimented with dirigible balloons for war purposes and has participated in several international balloon races, winning the James Gordon Bennett cup in 1906. He has taken part in the experiments at St. Louis, and has made ascensions with Orville Wright at Fort Myer, Va.

PROFESSIONAL SESSIONS

Thursday, December 3, 9.30 a.m., Main Auditorium

MACHINE SHOP PRACTICE

Efficiency Tests of Milling Machines and Milling Cutters, A. L. DeLeeuw

The Development of a High Speed Milling Cutter, Wilfred Lewis and W. H. Taylor.

Metal Cutting Tools Without Clearance, James Hartness.

Interchangeable Involute Gear Tooth Systems, Ralph E. Flanders.

Spur Gearing on Heavy Railway Motor Equipments, Norman Litchfield.

The papers at this session treat of three distinct and timely subjects upon the most advanced practice in machine shop work. The first two papers give the results of important tests upon milling cutters and milling machines and include data upon which information has previously been lacking.

The paper upon Metal Cutting Tools without Clearance sets forth some radically new principles in respect to lathe tools and is profusely illustrated from photographs showing methods and results obtained in a long series of original experiments.

The two papers upon gearing bring up the question of the design of gears for heavy duty and compare such gears, point by point, with gears made according to the present standard involute system. This session will be of unusual interest to all connected with the manufacture of machinery and is one that no machine constructor within reach of New York can afford to miss.

Luncheon will be served on the fifth floor of the building at 1 p.m. to members and guests.

Thursday, 2 p.m., Main Auditorium

MISCELLANEOUS PAPERS

ARTICULATED COMPOUND LOCOMOTIVES, C. J. Mellin.
LIQUID TACHOMETERS, Amasa Trowbridge.
TRAINING WORKMEN, H. L. Gantt.
SALT MANUFACTURE, George B. Willcox.
INDUSTRIAL PHOTOGRAPHY, S. Ashton Hand.
(Illustrated by Lantern Slides).

GAS POWER SECTION

Thursday, 2 p.m., Auditorium, Sixth Floor

SIMULTANEOUS SESSION

Business meeting and election of officers.
REMINISCENCES OF A GAS ENGINE DESIGNER, L. H. Nash.
(Illustrated by Lantern Slides).
POSSIBILITIES OF THE GASOLENE TURBINE, Prof. F. C. Wagner.

RECEPTION

Thursday, 9 p.m.

The President and President-elect will receive the members and guests in the Auditorium of the Engineering Societies Building. Dancing will follow the reception and will continue throughout the evening on the fifth floor. Supper will be served from ten until twelve o'clock. In order to avoid crowding, it is suggested that if those who must go out of town be served as near after ten o'clock as possible and those who live in town delay their supper, all may be served with convenience. Cards of admission will be required from all members and guests, and can be procured at the Registration Desk.

PROFESSIONAL SESSION

Friday, December 4, 9.30 a.m., Main Auditorium

EXPERIMENTAL DATA

Physical Properties of Carbonic Acid and the Conditions of its Economic Storage for Transportation, Prof. R. T. Stewart.

The Slipping Point of Rolled Boiler Tube Joints, Prof. O. P. Hood and Prof. G. L. Christensen.

Tests on Friction Clutches for Power Transmission, Prof. Richard G. Dukes.

An Averaging Instrument for Polar Diagrams, Prof. W. F. Durand.

RESTRICTIONS ON REPUBLICATION OF ARTICLES IN THE JOURNAL REMOVED

The Secretary is pleased to announce that all material appearing in The Journal may be republished without restriction. Heretofore papers have not been released until the date of the meeting at which they were to be presented. The usual footnote to this effect, which has appeared with each paper, will now be omitted, and the press throughout the world are invited to republish these papers immediately, in part or in whole.

By this means the widest possible publicity will be given to the contributions of the various authors, and greater interest in the

meetings will be awakened among engineers, particularly if interested in any special subject to come up for discussion. It is hoped that the free and unrestricted distribution of the material contributed to the Society will redound to the benefit both of the Society and of the profession. It is believed that this step will meet with general approval.

RESOLUTIONS TO MR. CHAS. F. SCOTT, PAST PRESIDENT OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

A testimonial in recognition of the valuable services rendered by Mr. Charles F. Scott, during the inception, construction and completion of the Engineering Societies Building, was tendered by the American Institute of Electrical Engineers at their annual meeting at Atlantic City, June 30.

The meeting presented a set of engrossed resolutions declaring that "To Mr. Scott's engineering experience, to his watchful care and his thorough appreciation of the requirements of the future as well as of the present, especially to his controlling influence in bringing about the full realization of the plan which at the outset seemed only visionary, the electrical engineers of America are and will, for all time, be indebted."

It was further resolved that the Institute tender its sincere thanks to Mr. Scott as a trustee for his devotion to its interests throughout his term as a member of the Joint Building Committee and of the Board of Trustees of the United Engineering Society.

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

The regular meeting of the American Institute of Electrical Engineers was held in the auditorium of the Engineering Societies Building in New York on Friday, November 13, at 8 p. m. A paper on Electric Heating was presented by W. S. Hadaway, Jr., electrical engineer, Westinghouse Electric and Mfg. Co., Pittsburg, Pa. The following engineers took part in the discussion: Messrs. H. N. Laty, W. N. Ryerson, H. P. Ball, W. S. Andrews and J. I. Ayer.

As heretofore announced, members of this Society are cordially invited to the meetings of the American Institute of Electrical Engineers and the American Institute of Mining Engineers.

THE AMERICAN STREET AND INTERURBAN RAILWAY ASSOCIATION

The American Street and Interurban Railway Association held its annual meeting in Atlantic City, Oct. 12–16. A great many interesting features were discussed among which were the new "pay-as-you-enter" cars and many designs of the cars and of the fare boxes adapted to their use were displayed.

A railway testing machine of the Pennsylvania Railway Co. which determines the wearing qualities of different grades of steel rails on sharp curves was shown.

The following officers were elected for the year: President, J. F. Shaw of the Boston and Worcester Electric Co.; Vice-Presidents, H. W. Brady, Indiana Union Traction Co., Anderson, Ind.; T. N. McCarter, Public Service Railway Co., Newark, N. J.; C. N. Black, San Francisco, Cal.

THE NATIONAL IRRIGATION CONGRESS

The National Irrigation Congress was held in Albuquerque, Mexico, Sept. 29–Oct. 3. The aspect of irrigation as it touches the mechanical engineer was discussed in papers on hydro-electric plants in connection with large irrigation projects, and in a paper on the pumping of water for irrigation.

Prof. W. B. Gregory of Tulane University was appointed Honorary Vice-President for this occasion to represent the Society. He presented a paper on pumping for irrigation, a subject which is becoming of greater importance every year in arid sections of the West.

Addresses of welcome to the Congress were made by the Mayor of Albuquerque and by the Governor of New Mexico to which there was a response by the President of the Congress, Frank C. Goudy. A message was read from the President of the United States and further responses to the welcoming addresses were given by governors of the States, and by representatives of foreign nations, colonies and insular possessions.

Prominent engineers who made technical addresses were M. Réné Tavernier, chief engineer of the Department of Public Works of the French Republic, Vernon L. Sullivan, territorial engineer of New Mexico and engineer Lourenco Baeta Neves of Brazil.

A reception was given to the representatives of foreign nations, governors of States, delegates from institutions of science and learning and to all distinguished guests.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION

The National Society for the Promotion of Industrial Education will hold its second annual convention in Atlanta, Ga., Nov. 19–21. The sessions will be held in the House of Representatives of the State Capitol. Several addresses will be made, among which are the following: Industrial Training Through the Apprenticeship System, by E. P. Bullard, Bridgeport, Conn.; Promotion of Industrial Education by Means of Trade Schools, by Geo. N. Carman of Chicago and John M. Shrigley, Williamson, Pa.; Industrial Education in Public Schools, by Thomas M. Balliet, New York, and L. D. Harvey, Menominee, Wis.

THE VANDERBILT CUP RACE

Mr. A. L. Riker, a member of the Council of the Society, has the honor of having designed the Locomobile car which won the Vanderbilt cup—the first victory of an American car in an international road race.

Bridgeport, the home of the Locomobile Company, celebrated the victory on Monday, November 9, by declaring a holiday. During certain hours the streets were held open, permitting an exhibition of speed by the winning car.

The car was driven from New York to Bridgeport by George Robertson, who was the driver in the Vanderbilt race. It was accompanied by about 100 Locomobile owners, and was met at South Norwalk by the Bridgeport Automobile Club.

A banquet, at which Mr. Riker was a guest of honor, was given at the Hotel Stratfield, and was attended by Governor Rollin S. Woodruff of Connecticut, and Mayor Henry Lee of Bridgeport.

FORESTRY ON THE BILTMORE ESTATE

The "Forest Festival," celebrating the twentieth anniversary of the inauguration of forestry on the Biltmore Estate and the tenth anniversary of the establishment of the Biltmore Forest School, will be held at Biltmore, N. C., Nov. 26–28.

A cordial invitation is extended through Mr. Chas. E. Waddell, a member of this Society and engineer of the Biltmore Estate, to the members of this Society to attend the celebration. The program provides for excursions in carriages over the estate, inspecting various forest plantations (some of them 500 acres in extent) which were

replanted between 1889 and the present date. These forests comprise white pine, yellow pine, ash, maple, oak, chestnut, hemlock, poplar and walnut.

Logging operations will be shown and the second growth obtained in the primeval forest logged conservatively in 1895, 1896 and 1897 will be pointed out.

The Biltmore Estate of 130 000 acres, owned by Mr. Geo. W. Vanderbilt, is located at Biltmore, N.C., a suburb of Asheville. The experiments in forestry there made are the first on American soil and are interesting as showing the possibilities of forestry as a sylvicultural and financial enterprise.

The direction of the celebration will be under C. A. Schenck, Ph.D., in charge of the forest department; R. R. Swope, D.D., Rector of All Souls' Church; C. D. Beadle, in charge of the landscape and nursery department; A. S. Wheeler, M. D., in charge of the agricultural department; and Charles E. Waddell, in charge of the electrical department.

Visits will be made to the herbarium, nurseries, dairies, and live stock farms.

Detailed information about hotels and transportation will be furnished by the Committee upon request.

THE PAN-AMERICAN CONGRESS

Invitations have been extended to the four National Engineering Societies, The American Society of Civil Engineers, The American Institute of Mining Engineers, The American Society of Mechanical Engineers and The American Institute of Electrical Engineers by the Chilian Government to participate in the Pan-American Congress to be held in Santiago, Chile, December 25 to January 5.

THE TECHNOLEXICON

Der Verein Deutscher Ingenieure has again taken up the work of the Technolexicon which it was compelled to abandon a year ago on account of the great scope of the work which involved expenditures that the German Society did not wish to undertake.

The announcement of the renewal of the work was made at the annual meeting in Dresden where its officers were empowered to negotiate with the Prussian State Government and the Government of the German Federation to complete the lexicon.

DE LAVAL MEDAL CONFERRED UPON MR. T. H. MILLER, MEMBER

A somewhat unusual though pleasant experience has befallen one of our members, Mr. Theodore H. Miller, of Poughkeepsie, N. Y., in the receipt of a silver medal, a few of which were struck in commemoration of the twenty-fifth anniversary of the incorporation in Sweden of the original or parent De Laval Separator Company.

The American De Laval Separator Company has a large factory in Poughkeepsie, of which Mr. Miller has been superintendent for several years, and the medal was given to him as being among the men who "have contributed largely to the practical success of the De Laval separator and the development of the De Laval organization throughout the world."

The medal itself is an artistic and beautiful piece of work, showing upon the obverse side the busts of Dr. Gustaf De Laval, the original inventor of the centrifugal cream separator, and Sir John Bernstrom, the head of the DeLaval organization; while on the reverse side is a representation of the Genius of Invention handing the separator to Mercury, the god of commerce, to be carried round the world.

THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS

The Society is invited by the Naval Architects and Marine Engineers to attend its sixteenth annual meeting to be held in the Engineering Societies Building, New York, November 19 and 20.

The following papers will be presented and discussed:

The War Eagle, Charles H. Cramp, Vice-President; Practical Methods of Conducting Trials of Vessels, Col. E. A. Stevens, Vice-President; The Influence of Midship Section Shape upon the Resistance of Ships, Naval Constructor D. W. Taylor, U. S. N., Vice-President; Further Experiments upon Longitudinal Displacement and its Effect upon Resistance, Professor H. C. Sadler; Further Analysis of Propeller Experiments, Clinton H. Crane; Deviation of the Compass Aboard Steel Ships; its Avoidance and Correction, Lieut. Commander L. H. Chandler, U. S. N; The Influence of Free Water Ballast upon Ships and Floating Docks, Naval Constructor T. G. Roberts, U. S. N.; Recent Inventions as Applied to Modern Steamships, W. Carlile Wallace; Service Test on the S. S. Harvard, By Professor C. H. Peabody; Trials of the U. S. Scout Crusier Chester fitted with Parsons Turbines, Charles P. Wetherbee; Some Remarks on the Steam Turbine, J. W. Powell; Ship Building on the Great Lakes, Robert Curr;

The Steamer Commonwealth, J. H. Gardner and W. T. Berry; Fire Boats, Charles C. West; Sea Going Suction Dredges, Thomas M. Cornbrooks; The British International Trophy Race of 1908, W. P. Stephens; Transportation of Submarines, Naval Constructor W. J. Baxter, U. S. N.

RAILROAD TRANSPORTATION NOTICE

Special concessions have been secured for members and guests attending the Annual Meeting in New York, December 1–4, 1908.

The special rate of a fare and three-fifths for the round trip, on the certificate plan, is granted when the regular fare is 75 cents and upwards, from territory specified below.

a Buy your ticket at full fare for the going journey, between November 27 and December 3 inclusive. At the same time request a certificate, *not a receipt*. This ticket and certificate should be secured at least half an hour before the departure of the train.

b Certificates are not kept at all stations. Find out from your station agent whether he has certificates and through tickets. If not, he will tell you the nearest station where they can be obtained. Buy a local ticket to that point, and there get your certificate and through ticket.

c On arrival at the meeting, present your certificate to Mr. S. Edgar Whitaker at the Headquarters. A fee of 25 cents will be collected for each certificate validated. No certificate can be validated after December 4.

d An agent of the Trunk Line Association will validate certificates December 2, 3 and 4. No refund of fare will be made on account of failure to have certificate validated.

e One hundred certificates must be presented for validation before the plan is operative. This makes it important to ask for certificate, and to turn it in at Headquarters. Even though you may not use it this will help others to secure the reduced rate.

f If certificate is validated, a return ticket to destination can be purchased, up to December 8, on the same route over which the purchaser came, at three-fifths the rate.

This special rate is granted only for the following:

The Trunk Line Association:

All of New York east of a line running from Buffalo to Sal-

amanca, all of Pennsylvania east of the Ohio River, all of New Jersey, Delaware and Maryland; also that portion of West Virginia and Virginia north of a line running through Huntington, Charleston, White Sulphur Springs, Charlottesville and Washington, D. C.

The Central Passenger Association:

The portion of Illinois south of a line from Chicago through Peoria to Keokuk and east of the Mississippi River, the States of Indiana, and Ohio, the portion of Pennsylvania and New York north and west of the Ohio River, Salamanca and Buffalo, and that portion of Michigan between Lakes Michigan and Huron.

The New England Passenger Association, except via Bangor and Aroostook R. R. and Eastern Steamship Co., and N. Y. O. & W. R. R.

Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut.

The Eastern Canadian Passenger Association:

Canadian territory east of and including Port Arthur, Sault Ste. Marie, Sarnia and Windsor, Ont.

PERSONALS

Mr. John L. Bacon is at present engaged upon a project at South Pasadena, Cal. He has formerly had charge of the shop work at the University of Chicago, and in addition has acted as Mechanical Engineer for the Chicago Reduction Co.

Mr. Charles W. Comstock, recently with Comstock, Jones & Co., has been appointed President of The Comstock Brass Foundry Co. of Cleveland, Ohio.

Mr. G. W. Dickie, for 23 years manager of the Union Iron Works, San Francisco, and for about 2 years at the New York Shipbuilding Company's yard superintending the building of the steamships for the Pacific Coast Company, has opened an office as Consulting Engineer and Naval Architect, at 24 California St., San Francisco.

Mr. Arthur J. Frith, who has recently had a consulting engineering office at 39 Cortlandt St., New York, has accepted a position as associate professor of experimental engineering at Armour Institute of Technology, Chicago, Ill.

Mr. George O. Haskell, formerly with the Southern Cotton Oil Company of New York, has joined the Fidelity Cotton Oil and Fertilizer Co. of Houston, Texas, in the capacity of Vice-President.

Mr. Harry C. Hutchins, who has been associated with the American Bridge Co. of New York as Draftsman, has been appointed Structural Draftsman of the Public Service Commission, 154 Nassau St., New York.

Mr. John H. Kelman, who has recently been associated with the National Conduit and Cable Co., Hastings-on-Hudson, as Superintendent of the enameled wire department, has been appointed General Eastern Representative of the Kelman Electric and Manufacturing Co. of Los Angeles, Cal., with office in Brooklyn, N. Y.

Mr. C. J. Larson, who has been associated with the Allis-Chalmers Co., New York, as District Superintendent of Erection, has entered the service of the Union Electric Co., Dubuque, Ia., in the capacity of Chief Engineer.

Mr. John E. Lord, recently connected with The Hooven, Owens, Rentschler Co., Chicago, Ill., has been engaged by the Pressed Steel Turbine Company of America, and expects to open headquarters in Cincinnati in the near future.

Mr. Theo. T. Mersereau, formerly U. S. Local Inspector of steam vessels for the Port of New York and later proprietor of an Academy for Marine Engineering, is now representing The Casey-Hedges Co. of Chattanooga, Tenn., as Eastern Sales Agent, located at 100 William St., New York.

Mr. Frederick Scherr, Jr., who has been connected with the N. Y. C. & H. R. R. R. Co. as Assistant Engineer, has accepted a position with The Fajardo Sugar Co. of Fajardo, Porto Rico.

Mr. John Sturgess, who has recently been connected with the Sturgess Governor Engineering Co., Troy, N. Y., as General Manager, has accepted a position in the same capacity with The Lombard & Replogle Engineering Co., Akron, Ohio.

Mr. William H. Winterrowd, who has formerly been connected with the Lake Shore and Michigan Southern Railway Co., Elkhart, Ind., has been engaged by The Lake Erie Alliance & Wheeling Railroad Co., Alliance, O., as Roundhouse Foreman.

Mr. Robert York, who has been Vice-President and Treasurer of the Bluff City Lumber Co., and 2d Vice-President of the Citizens' Light and Transit Co. of Pine Bluff, Ark., has been appointed Vice-President of the York-Browning Lumber Company, Memphis, Tenn.

Mr. Howard E. Coffin, designer of the Chalmers-Detroit car, and chairman of the executive committee of the Mechanical Branch of the Association of Licensed Automobile Manufacturers, recently sailed for England and will also visit France, Germany and Italy. He will make a report to the Mechanical Branch of the Association of Licensed Automobile Manufacturers on any items of interest appearing at the Olympia Show in London and the Automobile Salon in Paris and in the industry so far as design and production are concerned.

Mr. Chester B. Albree presented a paper on Simplification of Spring Formulae at a meeting of the mechanical section of the Engineers' Society of Western Pennsylvania.

Mr. Earle J. Banta, Mechanical Engineer, Isthmian Canal Commission, Panama R. R. and S. S. Lines, has been appointed a member of a committee to prepare standard specifications for frogs, switches and switchboards for the Panama Railroad.

Mr. William H. Boehm is the author of a paper on The Most Frequent Cause of Boiler Explosions, which appeared in the October 13 number of Power.

Prof. Wm. D. Ennis of the Polytechnic Institute of Brooklyn has an article in the October 20 issue of Power on Allowing for the Expansion of Steam Pipes.

Prof. Wm. T. Magruder of Ohio State University is the author of Gas Engine Guarantees Technically Considered, which appeared in the October 9 issue of The Mechanical World.

Mr. R. E. Mathot of Brussels, Belgium, has published in the October 15 issue of Gas and Oil Power (London) a paper on Systems of Governing Valve Gears of European Internal Combustion Engines.

Mr. James McNaughton, formerly Manager of the American Locomotive Co., Schenectady, N. Y., has been appointed Vice-President of that Company.

Mr. Oscar E. Perrigo has contributed an article on System for Filing Technical Literature to the October 16 issue of The Canadian Manufacturer.

Mr. William L. Reid has succeeded Mr. McNaughton as Manager of the American Locomotive Company, Schenectady, N. Y. Mr. Reid was formerly superintendent of the Company.

Geo. F. Swain, Professor of Civil Engineering, Massachusetts Institute of Technology, has been appointed by President Roosevelt a member of the Inland Waterways Commission.

Prof. C. C. Thomas, author of the exhaustive article on the Specific Heat of Superheated Steam presented before the December meeting of the Society, has resigned his professorship of the Department of Marine Engineering, Sibley College, Cornell University, to accept the Chair of Mechanical Engineering at the University of Wisconsin, Madison, Wis.

Mr. Charles E. Waddell has contributed a paper on Problems and Possibilities of Electrical Heating, to the September issue of the Proceedings of the Engineering Association of the South.

Mr. Theo. Weinshank of Indianapolis, Ind., is the author of Cast Iron Heaters for Hot Blast Work which appeared in the October number of Engineering Review.

Mr. Arthur West has recently been placed in charge of the power department of the Bethlehem Steel Company, which has recently begun the manufacture of power generating machinery, including internal combustion engines. Mr. West has formerly been associated with the Allis-Chalmers Company and with the Westinghouse Machine Company.

Prof. Sherman M. Woodward has been appointed Professor of Hydraulics and Engineering Materials in the Department of Mechanical Engineering of the State University of Iowa. He has recently been connected with the United States Department of Agriculture as Supervising Drainage Engineer. Professor Sherman and Prof. C. E. Lucke are the joint authors of Tests of Internal Combustion Engines.

Mr. Orosco C. Woolson has written a paper on burning shavings and sawdust, approved types of furnaces, reasons, etc., which has been published in the October 13 issue of Power.

THE JOURNAL

OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

VOL. 30 DECEMBER 1908 NUMBER 12

THE ANNUAL MEETING

THE Twenty-ninth Annual Meeting will present some of the most interesting features ever considered by the Society. Aëronautics has been engaging the attention of the mechanical engineer since the recent successful demonstrations of aëroplanes, overcoming the hitherto unsurmountable difficulty of flying a machine heavier than air. The paper by Maj. George O. Squier and the lecture by Lieut. Frank P. Lahm present to the Society the most interesting and authentic information available at the present time. Major Squier has gathered data from the Department of War at Washington, and records of our naval attachés in foreign countries have been open to his search, so that his paper on "The Present Status of Military Aëronautics" will comprise the progress toward the solution of the problems in Europe as well as in this country. He will point out the problems yet to be solved, and the important part the mechanical engineer may take in this new branch of the profession.

Other sessions, as will be seen by the program following, and by the papers published in this and previous issues of The Journal, will be full of interest, and they cover a variety of subjects so that all members may find something that will offer information touching some branch of their work.

Special efforts will be made to extend hospitality to the out-of-town members and ladies and by a series of social functions—luncheons,

teas, receptions, etc., promote an atmosphere of sociability which will facilitate the forming of friendships, a most important opportunity of the convention.

LECTURE TUESDAY, DEC. 1, 7.45 P. M., ON PHOTOGRAPHY OF THE STARS

A lecture of extraordinary interest on Photography of the Stars, by Prof. John A. Brashear, which has not been mentioned before in The Journal, will be a most attractive feature of the opening session. It is hoped that the members and guests will make it a point to attend this session.

THE LADIES RECEPTION COMMITTEE

The Ladies Reception Committee will be in charge of the entertainment of ladies. The Executive Committee is composed of Mrs. Jesse M. Smith, *Chairman*, Mrs. David H. Gildersleeve, Mrs. H. G. Torrey, Mrs. A. L. Williston, Mrs. Ira H. Woolson, Mrs. Calvin W. Rice, Mrs. F. R. Hutton, Mrs. J. E. Jones and Mrs. G. L. Knight. The ladies' headquarters will be open from Tuesday noon until Friday noon in the Society's rooms on the eleventh floor.

Tea will be served every afternoon from 4 until 6, and guides have volunteered to conduct ladies or parties upon shopping tours and to points of interest in the city. One member of the Executive Committee and her assistants will be in charge of the ladies' headquarters at all times and will be most happy to give any information or attention which the guests may desire.

The ladies are especially invited to come to the Society Rooms Tuesday, the first day, and become acquainted

HEADQUARTERS

The Headquarters will be established in the foyer on the first floor of the Engineering Societies Building. Members and guests are requested to register immediately upon arrival, and receive a badge and program. Railroad certificates should be presented at that time for validation. The Headquarters and general arrangements will be in charge of Mr. S. Edgar Whitaker, Office Manager, Badge No. 3706.

HOTEL ACCOMMODATIONS

It is not possible for the Secretary to undertake to reserve hotel accommodations for the visiting members. They are asked to communicate directly with the hotel at which they wish to stop.

THE MEETINGS COMMITTEE

The Meetings Committee is in charge of the convention. It is composed of Messrs. Charles Whiting Baker, *Chairman;* Willis E. Hall, Wm. H. Bryan, L. R. Pomeroy, and Charles Edward Lucke.

ENTERTAINMENT PROGRAM

A separate program outlining the social entertainments, excursions, etc., for both members and ladies, will be distributed at the meeting.

BADGE NUMBERS

The officers of the Society and the officials of the meeting will be designated by the following badge numbers:

No. 1480	Mr. M. L. Holman, *President*	
No. 3387	Hon. Wm. H. Wiley, *Treasurer*	
No. 1566	Prof. F. R. Hutton, *Honorary Secretary*	
No. 445	Mr. A. W. Burchard, *Chairman Finance Committee*	
No. 2594	Mr. Calvin W. Rice, *Secretary*	
No. 1077	Mr. Lester G. French, *Editor*	
No. 3706	Mr. S. Edgar Whitaker, *Office Manager*	
No. 2911	Mr. Jesse M. Smith, *Nominee for President*	
No. 139	Mr. C. W. Baker, *Chairman*	*Meetings Committee*
No. 1267	Mr. W. E. Hall	*Meetings Committee*
No. 425	Mr. W. H. Bryan	*Meetings Committee*
No. 2475	Mr. L. R. Pomeroy	*Meetings Committee*
No. 1945	Prof. C. E. Lucke	*Meetings Committee*
No. 1477	Mr. H. F. Holloway, *Chairman Reception Committee*	

MEMBERS REGISTER

Two editions of the printed Members Register will be issued. The first will include the names of those registered before 9 p.m. Tuesday, and will be distributed at the morning session on Wednesday. The second edition will contain the names of those registered before noon on Thursday. It will be distributed at the reception on Thursday evening.

PROGRAM OF THE NEW YORK MEETING

OPENING SESSION

Tuesday, December 1, 7.45 p.m., Auditorium
(Please note change in hour.)

THE PRESIDENT'S ADDRESS

The Conservation Idea as Applied to The American Society of Mechanical Engineers, M. L. Holman.

CONFERRING HONORARY MEMBERSHIP

Honorary membership in the Society will be conferred upon Dr. John A. Brashear, after which Dr. Brashear will make an address on the "Photography of the Stars," illustrated by beautiful lantern slides.

Members and guests are especially requested to be present at this session, as the conferring of Honorary membership is an important event in the history of the Society and the lecture will be particularly enjoyable.

PROFESSIONAL SESSION

Wednesday, December 2, 9.30 a.m., Auditorium

Annual business meeting. Reports of the Council, Tellers, and Standing and Special Committees. New business may be presented at this session.

The Engineer and the People, Morris Llewellyn Cooke.

The Present Status of Military Aëronautics, Major Geo. O. Squier, Acting Chief Signal Officer, U. S. A.

This will be the first presentation of the subject of aëronautics before a national engineering society in America. By reason of his con-

nection with the Signal Service, Major Squier has had an opportunity to observe at close range the construction, equipment and principles of operation of heavier-than-air machines and dirigible balloons. The material upon aviation on file at the War Department, including the data sent in by the attachés in different countries, is the most complete in this country, and has been at the disposal of Major Squier for the preparation of his paper.

Luncheon will be served at 1 p.m. on the fifth floor of the building to members and guests.

PROFESSIONAL SESSION

Wednesday, December 2, 2 p.m., Audi'orium

STEAM AND POWER PLANT PAPERS

A METHOD OF OBTAINING RATIOS OF SPECIFIC HEAT OF VAPORS, A. R. Dodge.

THE TOTAL HEAT OF SATURATED STEAM, Dr. Harvey N. Davis.

FUEL ECONOMY TESTS AT A LARGE OIL BURNING ELECTRIC PLANT, C. R. Weymouth.

UNNECESSARY LOSSES IN FIRING FUEL OIL, C. R. Weymouth.

LECTURE

Wednesday, 8.15 p.m., Auditorium

AËRONAUTICS, Lieut. Frank P. Lahm, of the Signal Corps, U. S. A., a member of the Aëronautical Board.

This will be an illustrated lecture of interest to every member as well as to the ladies. Lieutenant Lahm has for many years experimented with dirigible balloons for war purposes and has participated in several international balloon races, winning the James Gordon Bennett cup in 1906. He has taken part in the experiments at St. Louis, and has made ascensions with Orville Wright at Fort Myer, Va.

PROFESSIONAL SESSIONS

Thursday, December 3, 9.30 a.m., Auditorium

MACHINE SHOP PRACTICE

EFFICIENCY TESTS OF MILLING MACHINES AND MILLING CUTTERS, A. L. DeLeeuw

The Development of a High Speed Milling Cutter, Wilfred Lewis and W. H. Taylor.

Metal Cutting Tools Without Clearance, James Hartness.

Interchangeable Involute Gear Tooth Systems, Ralph E. Flanders.

Spur Gearing on Heavy Railway Motor Equipments, Norman Litchfield.

Luncheon will be served on the fifth floor of the building at 1 p.m. to members and guests.

Thursday, 2 p.m., Auditorium

MISCELLANEOUS PAPERS

Articulated Compound Locomotives, C. J. Mellin.
Liquid Tachometers, Amasa Trowbridge.
Training Workmen, H. L. Gantt.
Salt Manufacture, George B. Willcox.
Industrial Photography, S. Ashton Hand.
(Illustrated by Lantern Slides).

Gas Power Section

Thursday, 2 p.m., Sixth Floor

SIMULTANEOUS SESSION

Business meeting and election of officers.
Reminiscences of a Gas Engine Designer, L. H. Nash.
(Illustrated by Lantern Slides).
Possibilities of the Gasolene Turbine, Prof. F. C. Wagner.

RECEPTION

Thursday, 9 p.m.

The President and President-elect will receive the members and guests in the rooms of the Society. Dancing will follow the reception and will continue throughout the evening on the fifth floor. Supper will be served from ten until twelve o'clock. In order to

avoid crowding, it is suggested that if those who must go out of town be served as near after ten o'clock as possible and those who live in town delay their supper, all may be served with convenience. Cards of admission will be required from all members and guests, and can be procured at the Registration Desk

PROFESSIONAL SESSION

Friday, December 4, 9.30 a.m., Auditorium

EXPERIMENTAL DATA

Physical Properties of Carbonic Acid and the Conditions of its Economic Storage for Transportation, Prof. R. T. Stewart.

The Slipping Point of Rolled Boiler Tube Joints, Prof. O. P. Hood and Prof. G. L. Christensen.

Tests on Friction Clutches for Power Transmission, Prof. Richard G. Dukes.

An Averaging Instrument for Polar Diagrams, Prof. W. F. Durand.

ELECTION OF JOHN A. BRASHEAR, HONORARY MEMBER

At the meeting of the Council Tuesday, November 10, Dr. John A. Brashear, of Allegheny, Pa., was unanimously elected Honorary Member of the Society, in response to a petition signed by the following members:

W. R. Warner
C. F. Brush
John Fritz
Chas. H. Morgan
Victor E. Edwards
C. M. Schwab
W. M. McFarland
Alexander Taylor
E. S. McClellan
George I. Alden
Joseph F. Klein
Chas. Wallace Hunt
Jesse M. Smith
Geo. W. Melville
Henry L. Barton
Wm. A. Bole
Walter C. Kerr
H. H. Westinghouse

Dr. Brashear is an expert in the manufacture and development of Astronomical and Physical Instruments of precision and an acknowledged leader in astronomical research.

He has freely given his services to the development and furtherance of technical education, and is at present a member of the Board of Trustees of the Carnegie Institute and Library and of the Carnegie

Technical Schools of Pittsburg. He also served as Acting Chancellor of the Western University of Pennsylvania and as Acting Director of the Allegheny Observatory. He has received from the Western University of Pennsylvania, the degree of Sc.D., from Washington and Jefferson College, the degree LL.D., and the same from the University of Worcester.

Professor Brashear began his scientific work about thirty years ago with Professor Langley, then Director of the Allegheny Observatory. After Professor Langley was called to Washington as head of the Smithsonian Institution, he continued to refer his most difficult scientific problems to Professor Brashear for solution.

Professor Brashear's most important work has been the designing and developing of the spectroscope for astronomical uses, particularly with reference to the mechanical features. He completed for the Lick Observatory, in 1888, the spectroscope for the 36-in. telescope, furnishing the mechanical parts. At the same time the complete small spectroscope was furnished by Professor Brashear including the prisms and all other optical parts.

The excellence of the work which has been done by Professor Keeler at the Lick Observatory is freely attributed to Professor Brashear's skill and genius, and many of the spectroscopes from the principal observatories of the world have been sent to Professor Brashear to be reworked and remodeled.

Professor Brashear is a fellow of the American Association for the Advancement of Science, and of the Royal Astronomical Society of Great Britain; Past-President of the Engineers' Society of Western Pennsylvania, and the Pittsburg Academy of Arts and Sciences; Honorary Member of the Royal Astronomical Society of Canada; Member of the American Astrophysical Society, the American Philosophical Society, the British Astronomical Association, La Société Astronomique de France, La Société Astronomique de Belgique.

The formal presentation of Honorary Membership to Doctor Brashear will take place at the opening session Tuesday evening, December 1, at 7.45 o'clock.

Dr. Brashear will give an address beautifully illustrated with lantern slides on "The Photography of the Stars" which will be a feature of the Annual Meeting.

The ceremony of conferring honorary membership is an event in the history of the Society, which is an inspiration to all members to witness.

REPORTS OF THE STANDING COMMITTEES TO THE COUNCIL

The Finance Committee

On October 17, 1907, The Mechanical Engineers Library Association was consolidated with the Society under the corporate name of The American Society of Mechanical Engineers, in connection with which the surplus of the M. E. L. A., including the profits from the sale of the house at 12 West 31st Street, the whole amounting to $83 632.15, was transferred to the treasury of the Society. Of the funds made available from this source, $63 000 was expended in the reduction of the mortgage on the land on which the building of the United Engineering Societies was erected. The balance was returned to the treasury of the Society and appears in the statement below.

RE-INVESTMENT OF TRUST FUNDS

During the year the several trust funds of the Society have been reimbursed to the extent of the investments made by them in assuming a part of the obligations incurred in connection with the Building of the Engineering Societies. The principals of each of the several trust funds have been restored to the full amount and the unexpended income at 4 per cent has been added in each case. It will be of interest to note the history of these funds.

Library Fund. The Library fund was first established at the Council meeting held on June 25, 1884. From this time the contributions have been received for this fund and the interest used in paying for the purchase of books and the maintenance of the library.

In April, 1902, as a result of a joint meeting of the Finance and Executive Committees, a pamphlet was issued containing a financial report and certain recommendations which were subsequently adopted by the Council. One of these resolutions (See p. 9, vol. 24 of the Transactions, also Council Records) provided that one per cent of the gross receipts from membership dues during the fiscal year should be credited to the library fund. The intent of the com-

mittees appears to have been that the income of these funds be used for the purchase of new books, building and models. At the present time this fund amounts to $4902.71.

Weeks Legacy Fund. This fund was established in May, 1904, by bequest from the estate of Geo. W. Weeks, a member of the Society, who donated an amount to the Society for library purposes. The amount of the bequest was $1957.

Life Membership Fund. This fund was established in accordance with Article 22 of the Constitution. The first contribution was received May 12, 1880. At the present time there are 104 Life Members, and the fund amounts to $35 151.07. The income is used for the current expenses and appears under the classification of dues.

Reserve Fund. This fund originated at a meeting of the Financial and Executive Committees in March 1902, and was established by the Council April 22, 1902. The evident purpose of this fund is that the initiation fees shall be treated as a special reserve fund and that at the end of each fiscal year ten per cent of the entire amount in the fund be transferred to the annual income. This fund at the end of this fiscal year amounts to $32 759.95.

Thurston Memorial Fund. This fund was established soon after the decease of Dr. Robert H. Thurston, the first president of the Society, and consists of subscriptions for the purpose of providing for the Society House a bronze bust of Dr. Thurston as a memorial. At the end of the fiscal year this fund amounted to $797.19.

It would seem advantageous at this time to enlarge upon the fact that the Society is in a position to receive and invest trust funds for the development of the various features of its work, and endowments for the benefit of the Society's activities, and to secure their continuance, will be highly appreciated and can be utilized most advantageously.

The details of the Society's investments and resources are shown in the statement herewith submitted.

Respectfully submitted,

Anson W. Burchard, *Chairman*
Arthur M. Waitt
Edward F. Schnuck
J. Waldo Smith
A. C. Dinkey

Finance Committee

PEIRCE, STRUSS AND COMPANY
CERTIFIED PUBLIC ACCOUNTANTS
40 Cedar Street, New York

November 4, 1908

MR. ANSON W. BURCHARD
CHAIRMAN FINANCE COMMITTEE
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 West 39th Street, New York

Dear Sir:

Having audited the books andaccounts of The American Society of Mechanical Engineers for the year ended September 30, 1908, we hereby certify that the accompanying Balance Sheet is a true exhibit of its financial condition as of September 30, 1908, and that the attached statements of Income and Expense and Cash Receipts and Disbursements are correct.

PIERCE, STRUSS AND COMPANY
Certified Public Accountants

PEIRCE, STRUSS AND COMPANY
CERTIFIED PUBLIC ACCOUNTANTS
40 Cedar St., New York

November 4, 1908

MR. ANSON W. BURCHARD,
CHAIRMAN FINANCE COMMITTEE,
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS,
29 West 39th St., New York

Dear Sir:

In accordance with your instructions, we have audited the books and accounts of The American Society of Mechanical Engineers for the year ended September 30, 1908.

The results of this examination are presented in three exhibits, attached hereto, as follows:

Exhibit A Balance Sheet, September 30, 1908.
Exhibit B Income and Expenses for year ended September 30, 1908.
Exhibit C Receipts and Disbursements for year ended September 30, 1908.

We beg to present, attached hereto, our Certificate to the aforesaid exhibits.

Yours very truly,

PEIRCE, STRUSS AND COMPANY,
Certified Public Accountants

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
EXHIBIT A
Balance Sheet, September 30, 1908

ASSETS

Cash in bank	$13 458.98	
Petty cash on hand	250.00	$ 13 708.98
New York City 3½ per cent bonds 1954, par $35000		30 925.00
Equity in Societies Building (25 to 33 West 39th St.)	353 346.62	
Equity, one-third cost of land (25 to 33 West 39th St.)	180 000.00	533 346.62
Library books	$13 727.10	
Furniture and fixtures	3 084.02	
Stores, including plates and finished publications	10 875.55	27 686.67
Accounts receivable		
Membership dues	$4 439.75	
Initiation fees	705.00	
Sale of publications, etc	5 952.26	11 097.01
Advances account of land subscription fund		7 960.94
Advanced payments		4 819.47
Total assets		$629 544 69

LIABILITIES

Funds		
Land fund subscriptions	$ 1 475.84	
Library development fund	4 902.71	
Robert H. Thurston memorial fund	797.17	
Weeks legacy fund	1 957.00	
Life membership fund	35 151.07	$44 283.79
United Engineering Building Society (for cost of land)		81 000.00
Membership dues paid in advance	326.05	
Initiation fees paid in advance	40.00	366.05
Reserve (initiation fees)		32 759.95
Appropriation available to complete Volume 29 of Transactions		4 451.31
Membership dues uncollected	4 439.75	
Initiation fees uncollected	705.00	5 144.75
Current accounts payable		1 352.21
Surplus		460 186.63
Total liabilities		$629 544.69

EXHIBIT B

Income and Expenses for the Year Ended Sept. 30, 1908

INCOME

Membership dues	$46 891.80	
Initiation fees	3 639.99	
Interest library funds	223.50	
Sales, publications, badges, etc	1 906.97	
Adjustment of cost of building	3 346.62	
Miscellaneous	1 072.65	
		$57 081.53

EXPENSES

Transactions, volume 29, including estimated cost to complete	$ 6 100.00*	
Office administration, including salaries	20 497.13	
Meetings, annual, spring and monthly	5 237.99	
Proceedings	8 015.63	
Membership development	2 029.73	
Pocket list and year book	2 622.57	
Library	2 539.85	
United Engineering Society assessments	6 700.00	
Miscellaneous	1 526.16	
Total		55 269.06
Excess of income over expenses		1 812.47
		$57 081.53

*Actual cost to date	$1648.69
Estimate of amount required to complete	4451.31
" " " " " "	$6100.00

EXHIBIT C

Receipts and Disbursements for Year Ended Sept. 30, 1908

RECEIPTS

Membership dues and initiation fees	$51 442.43	
Membership dues and initiation fees, paid in advance	351.05	
Sales of publications, badges, advertising, etc	11 731.59	
Subscriptions to land fund	3 558.00	
Subscriptions to expense of annual meeting	1 865.00	
Transportation: Annual and Spring meeting	178.75	
Interest	1 504.56	
Cash exchanges, *per contra*	625.00	
Robert H. Thurston memorial fund	788.32	
Sale of property of Mechanical Engineers Library Association	83 632.15	
	$155 676.85	
Cash in banks and on hand, September 30, 1907	30 292.44	$185 969.29

DISBURSEMENTS

Disbursements for general purposes	$73 047.72	
Reduction of mortgage on land	63 000.00	
Interest on mortgage on land	4 278.08	
Investment in New York City bonds (3½ per cent 1954)	30 925.00	
Accrued interest paid on New York City bonds	384.51	
Cash exchanges, *per contra*	625.00	
	$172 260.31	
Cash in banks and on hand September 30, 1908	13 708.98	
		$185 969.29

Detail Statement Showing Receipts and Disbursements of the Trust Funds

LAND FUND

On hand October 1907	$2589.64
Received during the year	3558.00
Interest	84.86
	$6232.50
Interest on Mortgage Land Fund Committee	4756.66
Balance on hand	$1475.84

LIBRARY DEVELOPMENT FUND

On hand October 1, 1907	$1929.06
Received from surplus	2500.00
Membership fees	473.65
On hand	$4902.71

Interest $155.01 applied to current library expenses

ROBERT H. THURSTON MEMORIAL

Original fund	$788.32
Interest accrued	8.85
Total fund	$797.17

WEEKS LEGACY

On hand January 31	$1957.00

Interest $68.49 applied to purchase of library books

LIFE MEMBERSHIP

Balance October 9, 1907	$35 151.07

Interest $1109.20 applied to current expenses

THE PUBLICATION COMMITTEE

The Committee has examined carefully all of the papers presented at the meetings of the Society with a view of passing upon their suitability for publication in the Transactions. In this work it has endeavored to maintain the dignity of the Transactions, and to this end has considered it its duty to omit any objectionable personalities that might be found in the papers or in the discussions of the same. It has also endeavored to omit portions of papers or discussions where this could be done without eliminating ideas or data.

Proceeding in accordance with the above plan, the Committee has found it advisable to omit the publication of several papers, and in other cases has eliminated a considerable amount of matter from the text.

The Committee has made no endeavor to check up the detailed expenditures involved in publishing the Transactions, but has had the Secretary tabulate the expenditures involved in printing the Transactions for the last and previous years. The results of the tabulation are shown in the accompanying table.

COMBINED SUMMARY OF COST OF VOLUMES

Volume number	Year	Total cost	Cost omitting advance papers and revises	Advance papers	Revised papers	Number of copies	Number of pages	Total cost per copy	Total cost per 100 pages
19	1898	$10,973	....	....	....	2250	1033	$4.87	$0.471
20	1899	9,643	....	....	....	2300	1035	4.19	0.408
21	1900	12,798	....	....	....	2500	1177	5.12	0.435
22	1901	12,740	....	....	....	2600	1164	4.90	0.421
23	1902	10,678	$8,730	$1,249	$699	2600	878	4.10	0.467
24	1903	15,479	12,080	1,301	2,098	2700	1563	5.62	0.359
25	1904	15,146	11,006	2,864	1,276	3000	1155	5.04	0.436
26	1905	11,830	8,417	2,650	763	3300	841	3.58	0.425
27	1906	14,546	10,127	2,678	1,741	3750	909	4.14	0.414
28	1907*	18,930	9,925	....	....	4000	981	4.73	0.482

*$18 930 includes cost of Proceedings from October, 1, 1906, to September 30, 1907, also the cost of Transactions from October 1, 1906, to December 31, 1906. Previous to the publication of Volume 23, no separate accounts were kept for transactions, the same being included in general expense for printing.

The costs given in the above table include the amount expended in bringing out advance papers before the Proceedings took their place,

so that the figures given include the expense of all the printing charges in preparing the Transactions. The costs for Vol. 28 are in some cases estimated, whereas all the figures for other years represent the amount actually expended. It may be noted that the total cost for Vol. 28 is higher than for the preceding years. This is accounted for by the large number of folders in this volume, and by the fact that additional expense items are included to cover certain editorial work made necessary through a change in the form of the Proceedings.

Respectfully submitted

D. S. JACOBUS, *Chairman*
FRED J. MILLER
WALTER B. SNOW
H. W. SPANGLER
H. F. J. PORTER
Publication Committee

THE LIBRARY COMMITTEE

During the past year the conduct of the Library has been modified to the extent that the administration has been placed in the hands of a Chief Librarian in common with the libraries of the American Institute of Mining Engineers and the American Institute of Electrical Engineers. All employees are paid by the United Engineering Society, this expense being distributed among the Founder Societies. This action is in accordance with the action of the Council and the Detroit meeting, pursuant to recommendation made by the Chairman of the Library Committee after conference with the Chairman of the Founder Societies and the Trustees of the United Engineering Society. At the Detroit meeting the Council adopted the following resolutions:

First: That the administration of the library be placed in the hands of the chief librarian, all employees of the library to be subject to the direction of the said chief librarian. It was agreed that Miss L. E. Howard should be appointed chief librarian.

Second: That each new employee in the library shall be approved both by the authorized representative of the Founder Societies interested, and by the chief librarian.

Third: In the event of any employee not being satisfactory to said representative of the Founder Societies interested, or to the chief librarian, the fact shall be reported by the chief librarian to the House Committee, which shall have the power to act.

Fourth: That in the absence of the chief librarian, the House Committee shall have the right to specify an employee of the library to act as chief librarian, during such period of absence.

Fifth: That the United Engineering Society be requested to pay the salaries of all the library employees, and the amount to be repaid by the Founder Societies respectively shall be distributed in such proportion as may be jointly agreed upon.

This action relates solely to the administration of the Library, the acquisition and ownership of the books remaining wholly with the Society.

A gratifying number of books has been acquired by purchase during the year.

The library has also acquired donations through the generosity of Messrs. Henry R. Towne, and of Mr. H. H. Suplee, Members of the Society, and of Mrs. Annie M. Forney in memory of Matthias Nace Forney, deceased Member of the Society.

A complete list will be published in the Report to be distributed at the meeting.

The Society has received from Professor John E. Sweet, Past-President and Honorary Member of the Society, an original copper-plate impression of the Certificate of Membership in the Insurance Society of the Steam Engine Works of Messrs. Boulton & Watt at Birmingham, also a photograph of Watt's workroom at Heathfield Hall where this certificate was discovered. Mr. H. H. Suplee, Member of the Society, has presented a photograph of the original letter of Robert Fulton offering the steamboat to the French government in 1803, together with a photograph of the drawing which accompanied it.

It is to be hoped that other members of the Society will imitate these examples and make the Library the place for the deposit and preservation of books and engineering relics of value and interest. Gifts are especially desired of back numbers and volumes of periodicals to complete the sets now in the library, and an examination of the printed list of the sets now in the library will enable the gaps to be ascertained. Technical and engineering books are always welcome and any communications addressed to the Secretary of the Society upon these matters will be referred to the proper individuals for attention.

At the present time the Library receives 163 periodicals in exchange for its publications, and 40 periodicals as gifts.

The members of the Founder Societies should impress upon themselves the large opportunity for information and research afforded by the Library of the Engineering Societies.

It has a collection of 50 000 volumes of scientific and engineering works, and 450 current technical journals and magazines of Europe and America are readily accessible on the files of the reading room. The library is open every day except Sundays and holidays from 9 a.m. to 9 p.m. and librarians are constantly in attendance who will assist in finding information which the members and users of the library may not be able to locate.

A feature which is of continual service is a file of trade catalogues. An index to this file, both by subject and firm name, is kept, to make the information easily accessible.

Members are requested to recommend the purchase of books not in the library which in their opinion would add to its reliable resources. Cards are kept at the librarian's desk for that purpose and such recommendations to purchase are immediately transmitted to the Library Committee for consideration.

Members should invite their friends in the profession to make use of the library. Such a storehouse of information should be largely consulted and freely used for the advancement of science and engineering. The fact that it is a reference library free to all should be generally advertised.

The equipment and facilities of the library, located as it is in the headquarters of engineering—in a fireproof building with every convenience for indexing and caring for its gifts—must recommend it to friends who wish to place scientific and engineering literature or valuable engineering relics where they will be of the widest enduring influence.

It is maintained as a free reference library and with the idea of being of the greatest use and benefit to the profession, regardless of society affiliations. Librarians are always in attendance to give assistance in locating information, and it is the expressed aim of the Engineering Societies to make it of permanent and ever increasing service.

At the present time the Library Development Fund amounts to $4902.71 and the income for the year just ended was $155.01. The Weeks legacy is $1957.00, yielding an income of $68.49 for the fiscal year. These items of income have been used for the purchase of new books.

The Committee desire to place on record its appreciation of the work of Miss Isabel Thornton, the Librarian of the Society for the past thirteen years, who resigned her connection with the Library in October last.

At a meeting of the Council of the Society November 10, a vote of thanks was passed to Miss Thornton for her long and valued services and she carries with her the best wishes of all the members of the Society.

Respectfully submitted

H. H. SUPLEE, *Chairman*
A. W. HOWE
AMBROSE SWASEY
LEONARD WALDO
G. M. BASHFORD

Library Committee

THE MEETINGS COMMITTEE

The results of the year's work of your committee on meetings are better shown in the records of the nine meetings which have been held (seven monthly, besides the regular annual and summer conventions) and in the regular monthly publication of the Society, than they can be in any formal report. That the meetings have been highly successful in point of attendance and interest displayed by the membership is well known. We believe the summer convention at Detroit was particularly notable for the large attendance, the attractive excursions and other social features, and for the interest arising from the holding at the same time in the same city of the conventions of kindred organizations: viz: the Society for the Promotion of Engineering Education, the Society of Automobile Engineers and the Gas Power Section of our own Society. The rapid multiplication of engineering societies makes coöperation between the various groups in the choice of time and place of the annual conventions exceedingly advantageous.

Your committee has continued the policy adopted some years ago and has endeavored at each semi-annual meeting to secure groups of papers bearing upon some one or more subjects of current importance to the profession. We may cite by way of illustration the symposium on the conveying of materials presented at the Detroit Convention, and the session devoted to current improvements in machine shop practice which is on the program for the coming annual meeting at New York. We believe that by concentrating attention upon special subjects in this way more valuable information is elicited and it is brought together in one place, which makes it much more useful for reference.

Your committee has further continued its efforts to have the papers read before the Society cover a wide variety of professional work, so that the Society's publications may be made practically useful to all its members. While much has been accomplished in the matter, much remains to be done. There are still important departments of mechanical engineering work whose processes and methods and data are not recorded in our Transactions nor in those of any other engineering Society.

Undoubtedly the most important departure of the year just closed has been the engagement of Mr. Lester G. French as Editor of the Society's publications. With the great increase in the number of papers offered to the Society, it became absolutely necessary to have a competent editor to work in coöperation with your committee in the solicitation, examination and preparation of papers for publication. The interest of the meetings and the quality of the papers presented during the past year have been in no small degree due to Mr. French's ability and industry.

In order that this new departure in the Society's work might be carried on without burdening the Society's treasury, it was decided to insert advertising pages in the Society's Journal, and this change was inaugurated with very satisfactory results in the September number.

As a natural result of the expansion of the Society's work, the number of papers submitted to your committee for approval has very greatly increased, so that it becomes necessary to reject a considerable proportion of those which are offered. We believe this condition is one on which the Society is to be congratulated. The aim should be to make our publications of such high rank that it will be esteemed an honor for an engineer to have a paper accepted and published by our Society. This condition can only be brought about, however, if the number of papers offered continues materially in excess of the number which will be used, since it is only when such a surplus exists that proper selection becomes possible.

The objection will doubtless be raised that it is a disappointment to an individual author if after spending much time in the preparation of a paper it is finally rejected by the Society. The answer to this objection is that the interests of the profession—of the Society as a whole—are more important than the interests of any individual. If our Society finds itself obliged to reject an offered paper, its author is at liberty to seek publication through other channels.

There are, however, certain papers which by reason of great length,

or because they appeal only to some small branch of the profession would not be accepted by any journal published by private enterprise and are for the same reasons undesirable for our Society publications. We believe that certain papers of this class, where they contain material which ought in some form to be made available for record, can be treated in the way which has long been practiced by the Institution of Civil Engineers of Great Britain. That is, the paper as a whole can be filed in the Society's library for reference, and either its title only or some brief summary of the writer's conclusions and recommendations can be published in the Society's Journal.

By proper adoption of such a policy it should be possible for the Society to increase the number and variety of papers in its Transactions without increasing the bulk and expense of the volume. All of which is respectfully submitted.

CHARLES WHITING BAKER, *Chairman*
W. E. HALL
WM. H. BRYAN
C. R. POMEROY
CHARLES E. LUCKE

Meetings Committee

THE MEMBERSHIP COMMITTEE

The Membership Committee has, during the year, considered 399 applications for membership.

It has recommended that there be placed on the

Spring Ballot	140 names
Fall Ballot	191 names
Total on Ballot	331 names
It has not recommended	68 names
Total	399 names

Of the 331 recommended for ballot, 291 were candidates for new membership and 40 were promotions.

There are 87 applications, which have come in since the list was prepared for the Fall Ballot, which have not been considered by the Committee.

The experience of the past five years under the new Constitution has brought forcibly to the attention of the Committee several questions.

The question which has given the Committee probably the greatest trouble relates to C10 of the Constitution which attempts to define the qualifications of an Associate.

C10, as written, seems to call for *three different classes of Associates.*

a Men who would be qualified to be Members, *if they were old enough.*

b Men who would be "competent to take charge of engineering work" but supposedly *not* "*responsible*" charge.

c Men who would be qualified to "coöperate with Engineers."

These *three classes in one grade* lead to confusion in the minds of the Committee and must also be confusing to the membership of the Society.

It is the opinion of the Committee that C10 of the Constitution should be rewritten so as to make it more consistent and more explicit.

The Associate grade should not be a mere stepping stone from the Junior to the Member grade. The minimum age of the Associate and Member should be the same, namely 30 years. Persons should not be received into the Society as Juniors who are over 30 years of age.

The average of Juniors on this Fall's ballot is about 25.5 years. The average Junior will therefore have to wait only 4.5 years before he can apply for promotion; but during that time he will probably have decided on his career and will be able to state his experience and qualifications so that the Committee can decide intelligently whether to recommend him for Member or Associate.

It is the opinion of the Committee that C10 of the Constitution should be so worded as to include that large class of men who, while not engineers, may, by reason of their connection with science, the arts, or industries, or engineering construction, contribute to the advancement of the professional knowledge in engineering.

The number of Associates should be limited to 40 per cent of the total voting membership.

The Committee recommends the following, to take the place of the present C10, of the Constitution, as embodying its views.

"C10 An Associate shall be 30 years of age or over.

He must have been so connected with some branch of Engineering, or Science, or the Arts, or Industries, that the Council will consider him qualified to coöperate with engineers in the advancement of professional knowledge. He need not be an engineer."

The Committee also recommends the following to be added at the end of C11 of the Constitution.

"A person who is over 30 years of age can not enter the Society as a Junior."

The Committee particularly calls the attention of members of the Society who are supporting applicants for membership, to the desirability of giving information about such applicants as is *within their personal knowledge. "Hearsay" information is of very little value* to the Committee in determining the fitness of an applicant for membership.

Respectfully submitted

JESSE M. SMITH
HENRY D. HIBBARD
C. R. RICHARDS
FRANCIS H. STILLMAN
GEO. J. FORAN

Membership Committee.

MEETING OF THE COUNCIL

The regular monthly meeting of the Council was held in the rooms of the Society on the afternoon of Tuesday, November 10. There were present Messrs. G. M. Basford, P. W. Gates, Fred J. Miller, Past-Presidents F. R. Hutton, C. W. Hunt, F. W. Taylor, H. R. Towne and the Secretary. The meeting was called to order at 3.30 o'clock with Vice-President Gates in the chair.

DEATHS AND RESIGNATIONS

The Secretary reported the following deaths; M. Gustave Canet, Honorary Member, Dr. F. A. C. Perrine and Mr. H. F. Glenn.

The following resignations were accepted: Mr. Alfred Marshall, J. F. Wilcox, James Inglis, B. J. Dashiell, L. M. Northrup, Marcel L. Foucard, R. H. Whitlock.

JOHN A. BRASHEAR HONORARY MEMBER

Prof. F. R. Hutton and Mr. Geo. M. Basford were appointed Tellers to report on the Election of Prof. John A. Brashear to Honorary Membership in the Society. They presented a report to the Council which declared unanimous election.

FINANCE COMMITTEE

The Council approved the budget of the Finance Committee which is contained in the Finance Committee's report in this number.

LIBRARY COMMITTEE

The resignation of Miss Thornton as librarian of this Society was presented and on motion it was requested that the Secretary transmit to Miss Thornton a vote of thanks from the Council for her thirteen years of efficient and faithful service in the work of the Society and its library.

AFFILIATED SOCIETIES—STUDENT MEMBERSHIP

A draft of the rules of student sections was presented and was ordered sent to each member of the Council to come up for adoption at the next meeting.

In the meantime, the Secretary was requested to advise the Engineering Society of Stevens Institute of Technology and the Director of Sibley College that their requests for permission to form student branches of the Society have been granted.

AMERICAN MINING CONGRESS, PITTSBURG, PA.

The Council appointed Messrs. W. M. McFarland and W. A. Bole Honorary Vice-Presidents to represent the Society at the American Mining Congress, December 2–5, 1908.

AMENDMENTS TO BY-LAWS 44 AND 45

The amendments to By-Laws 44 and 45 proposed at a previous meeting of the Council were confirmed. The amendments are as follows:

B44 Omit the first word "that" and change "amended and annulled" to "amended or annulled."

B44 (That) standards for the conduct of the business affairs of The Society, of its professional or business meetings and of its Committees and their activities may be established, amended or annulled by a $\frac{2}{3}$ vote of the members of the Council present at a meeting provided that a written notice of the proposed addition or change may have been given at a previous meeting of the Council and provided further that the Secretary shall have sent to each member of the Executive Committee (acting as a Committee on Standards) a draft of the proposed addition or change at least two weeks prior to the meeting at which they are to be voted on.

B45 Omit the first word "That."

B45 (That) Directions for the conduct of the business affairs of the Society may be established by the Secretary and the work covered shall be carried out as provided by these Directions. These Directions may be added to, amended or annulled by the Secretary but it shall be his duty to send to each member of the Executive Committee (acting as a Committee on Standards) a draft of the change before it is put into effect.

THURSTON MEMORIAL

The Council voted to increase the membership of the Committee on the Thurston Memorial from three to five and appointed Mr. John W. Lieb, Jr., to serve upon that committee.

INTERNATIONAL STANDARD FOR GAS PIPE THREADS

The report of the Committee was received and the Secretary was directed to forward the report to our representative, M. Laurence V. Benet, as the views of the Committee appointed by the Council of the Society.

CODE FOR TESTING GAS POWER MACHINERY

The Secretary reported the recommendation of the Gas Power Section and the Council thereupon appointed the following committee of the Society on the Revision and Extension of the Code for Testing Gas Power Machinery, Prof. C. E. Lucke, *Chairman*, Prof. D. S. Jacobus, Messrs. Geo. H. Barrus, C. N. Scott and E. T. Adams.

VALUATION OF WATER POWERS

A communication from the National Conservation Commission was received requesting the assistance of the Society by the appointment of an Advisory Board for the purpose of valuing water power. In response to the request of the National Conservation Committee it was voted that the chair appoint a special committee of three members of the Society to serve until the Annual meeting of 1909 on the Advisory Board for valuing of water powers of the United States as a part of the work of the National Conservation Commission and that the expense incurred by the members of the Committee be defrayed by the Society.

COMMITTEE ON CORRESPONDENCE FILES

The Council appointed Prof. F. R. Hutton and Mr. Jesse M. Smith a Committee to advise what correspondence may be destroyed so as to reduce the large accumulation which is overburdening the files.

THE NOVEMBER MEETING

On the evening of November 10 the paper was presented by Mr. Franklin Phillips of Newark, N. J., upon "The High Powered Rifle and its Ammunition." Lantern slides showed details of the mechanism of modern types of rifles and ammunition, the results of target practice, and methods followed by marksmen in shooting.

Mr. Fred J. Miller, Vice-President, presided. Before proceeding with the paper the Secretary announced important features of the Annual Meeting to be held in December and impressed upon the audience the importance of all local members contributing to the success of the meeting by personal work and courtesies to the visiting members.

In introducing the speaker the Chairman said that as an engineer and a manufacturer he needed no introduction, but that many might not know that he was an expert in rifle practice and an instructor in the art in the New Jersey National Guard.

THE HIGH-POWERED RIFLE AND ITS AMMUNITION

The speaker stated that the present high-powered rifle is the outcome of the invention of the jacketed bullet by Major Rubin of Switzerland in 1883–6. About 1890 the Krag-Jorgenson rifle was selected by the Ordnance Board for the United States Army, which marked the beginning of the use of high-powered rifles for military purposes in this country.

This rifle, as well as all of the more modern rifles, are known as bolt guns. The breech action is similar in its movements to that of the common door bolt. The bolt is pushed forward in a line parallel with the axis of the bore and closed by giving the knob at one side of the bolt an angular movement to lock it in position. In arms of this kind the act of unlocking the breech block cocks the firing pin. The barrel of the Krag rifle is 30-caliber in its smallest diameter. It has four grooves, each 0.004 in. deep and the width of the land is $\frac{1}{3}$ that of the groove. The diameter of the bore is 0.308 in.

With the introduction of a higher powered rifle came possibilities

for a revival of long range shooting which had become a lost art in this country since the time of the famous matches at Creedmoor, and the New Jersey Rifle Association, composed of members, active and retired, of the National Guard of several states, challenged the Ulster Rifle Association of Ireland to a long range match for the historic Palma trophy.

This match was stated by the speaker to mark the beginning of the improvement of the military arm and its ammunition in the United States. The Americans shot the match with rifles made for them by the Remington Arms Co., and the Irish team used the Roumanian Mannlicher arm with Austrian ammunition. At the same time the National Rifle Association of America issued a challenge for the Palma trophy to the military nations of the world, which was accepted by a team from Canada.

Both the visiting teams won handsomely over their American confederates.

After the matches the Irish team allowed two American experts, Mr. William Hayes and Dr. Walter G. Hudson, to examine their Mannlicher rifles and ammunition. The bore of the barrel was calibrated by pushing through it a lead bullet of slightly larger diameter than the bore, after which the diameter of the bullet was measured.

The ammunition was also calibrated and found to be almost 0.001 in. larger than the caliber of the gun so that the bullet formed a gas-tight piston in its passage through the barrel. It was further found that the gun bands which secured the barrel to the stock contained a lining of chamois which was sufficiently elastic to allow the barrel to expand when heated from firing, without becoming distorted.

It was found that the barrels of the Krag rifles were cramped by having the bands too tight and that the ammunition used was smaller than the normal caliber of the arm. This caused the bullet to act like a leaky piston and the powder gases under the enormous pressure of 36 000 lb. per sq. in. would blow past the bullet, causing irregular results in shooting and tending to foul the barrel with a deposit.

It was further found that in long range shooting the bullet upset in its flight making an aperture in the target suggestive of a keyhole, which gave the name "key-hole shot" when the bullet was fired under such conditions. There were three ways of overcoming this. One was to increase the powder charge in the gun; another to decrease the length of the bullet, making it lighter; and the third to change the twist of the rifling. It was found that an increase of the powder charge by about 2¼ to 2½ grains, and the use of a 220-

grain bullet, produced the best results. The diameter of the bullet was also increased to 0.3085.

After these changes had been made a return match for the Palma trophy was shot in Canada with competing teams from several countries. While Great Britain won the match the American team did very much better than before and the performance of their arms was most creditable.

Many years' experience has led ballistic experts to believe that the danger zone of an arm would be materially increased by flattening the trajectory, and the invention of the pointed bullet now used was a marked advance in this direction. The 1903 model of the Springfield rifle with the 1907 ammunition are late developments in this direction. A feature of the barrel is its shortness so that the gun can be used by all branches of service, including the cavalry. A muzzle velocity of 2700 ft. per sec. is obtained and to show the power of penetration the speaker mentioned that in a skirmish by the National Guard at Somerville, N. J., a bullet fired at a 200-yd. range passed entirely through the lower flange of a railroad rail which formed the coping of the railroad pit. The steel was at least $\frac{3}{8}$ in. thick where the bullet went through, making a clean, round hole without any ragged edges. This type of rifle is a modification of the Mannlicher which has some points of superiority over the Krag. The speaker said this rifle was the best constructed piece of gun mechanism ever turned out in quantity by any armory. It has a remarkable record, notably in the longer ranges, very much less elevation being required on account of the quicker flight of the bullet and its pointed shape. Serious difficulties have been experienced, however, from the fouling of the barrel occasioned by the high temperature of the powder gases.

Mr. Phillips traced the development of gun sights. The 1884 model of 45-caliber Springfield rifle had a fine adjustable sight, but when the Krag rifle was adopted it was issued with the plain bar sight, having a V notch, and without any windage gage. This was displaced by the Phipps sight and in the 1903 model with the Dixon sight; and this in turn with one also known as the Phipps sight, which has adjustments enabling much better marksmanship. The speaker described a sight of his own invention in which the zero base is made movable and adjustable so that the arm will hit an objective point when on its zero reading.

DISCUSSION

The paper was discussed by Capt. Kellogg K. V. Casey of the E. I. Du Pont de Nemours Powder Co., who presented some data upon ammunition. He said that the utility of the 150-grain bullet used with the new rifle had been doubted, owing to the effect of the wind upon its flight, although the tables of the Ordnance Department and of rifle manufacturers were to the effect that a bullet of this weight would make the best flight. Efforts have been made to determine whether a heavier bullet would be more effective and he had found that one which weighed 180 grains would be the largest that could be used without projecting into the powder chamber. Bullets of this weight would have started at a velocity less than 2700 ft. per sec., otherwise there might be too great an increase in the pressure in the rifle. Formerly, when a barrel 30 in. long was used, 43 000 lb. per sq. in. was considered the highest allowable pressure; but was increased to 46 000 lb. per sq. in. when the shorter barrel was introduced, on account of the loss in velocity due to the shorter barrel. To secure a velocity of 100 ft. with a 180-grain bullet would require a pressure of 52 000 lb. per sq. in.

The problem was to get a charge that would give such a velocity that with the 180-grain bullet there would be the same angle of departure with a given time of flight as with the 150-grain bullet starting with a velocity of 2700 ft. In a series of tests conducted in New Jersey it was found that a velocity of about 2500 ft. would give the same angle of departure and time of flight in a thousand yards as 2700 ft. with the 150-grain bullet. The performance with a heavier bullet under these conditions was better and the fire more accurate than with a heavier bullet. The future use of a heavier bullet was predicted. The speaker did not attempt to explain the apparently contradictory results obtained with the heavier bullet under a low initial velocity.

The paper was also discussed by Mr. Frederick A. Waldron who stated that he was retained by the Ross Rifle Co., of Quebec, Canada, which manufactures the rifle for the Canadian government, and he gave some data of interest regarding this arm. It has a muzzle velocity of 3100 ft. per sec. and uses powder of the guncotton variety. The bullet is 0.28 in. in diameter and weighs from 140 to 160 grains. The trajectory at 800 yd. is 5 ft. 4 in., and the temperature of combustion with the powder used is so low that there is no trouble from erosion.

GENERAL NOTES

THE AMERICAN MINING CONGRESS

The Eleventh Annual Session of the American Mining Congress is called to meet at Pittsburg, Pa., December 2–5.

Representation has been invited from the United States Government, Governments of Foreign Nations, State Governments, Boards of Trade, Boards of County Commissioners and Supervisors, Mayors of Cities and Towns, Chambers of Commerce, Mining Organizations, State Mining Schools, Scientific Societies and Engineers' Associations.

The Council has appointed, as Honorary Vice-Presidents to represent the Society, Messrs. Wm. M. McFarland and Wm. A. Bole.

The purpose in view in holding the Mining Congress is to afford an open forum for the public discussion of all problems concerning the production, treatment, transportation, marketing and use of minerals and the relation of the mining industry to the State and federal governments, in connection with legislation to control, and investigation to stimulate and make possible a larger development and a wiser conservation of the mineral wealth of the United States.

The Congress has definite plans of operations, which have been developed through the deliberations at its annual conventions, for being of greater service to the mining industry by stimulating a greater development and a wiser conservation of the Nation's mineral resources, timber and water supply.

The relation of mining to agriculture, manufacturing and commerce, and means of coöperation will be discussed. The protection of the lives of miners is an important matter for consideration, as is shown by the statistics of the average loss of life in American mines during a period of five years which is 2.3 per 1000 men greater in America than in France, Belgium and Great Britain combined.

Other matters for consideration are protection to mining investors by federal and State legislation, the securing of federal aid for mining schools, the establishment of mining experiment stations, and a means for reducing excessive smelting charges.

THE NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION

The National Society for the Promotion of Industrial Education held a meeting in the Engineering Societies Building on Friday, November 13, to organize a State Branch of the Society.

The Branch is to aid in the development of public sentiment in the cities and towns of the State in order that the Industrial Education Bill, passed last year, may accomplish the largest possible results. The Chairman of the session was Dr. William H. Maxwell, City Superintendent of Schools, New York.

The following addresses were made: Industrial Education in Relation to the State, Mr. Charles H. Morse, Secretary of the Massachusetts Industrial Education Commission; The Needs of New York State from the Manufacturer's Point of View, Mr. James F. McElroy, Engineer, Consolidated Car Heating Co., Albany; The Industrial Education that Pays Best, Mrs. Anna Garlin Spencer, Society for Ethical Culture; Possibilities of Industrial Education in the City Evening Schools, Prof. James C. Monoghan, Principal Stuyvesant Evening Trade School.

The following members of this Society are officers of the State Committee for the National Society for the Promotion of Industrial Education: Prof. Charles R. Richards, Cooper Union, N. Y., *Chairman*; Prof. Arthur L. Williston, Pratt Institute, Brooklyn, Secretary, Mr. James F. McElroy, Albany, N. Y.

GIFT TO THE LIBRARY

We wish to acknowledge the gift from Mr. E. Graves, Superintendent of the Camden Iron Works, Camden, N. J., of a volume of "Industries and Iron" which is one of the list of books the Society advertised as necessary to complete the full set in the library.

We wish to call the attention of the members to the advertisement on page 8 and to ask that these volumes be supplied as far as possible.

PERSONALS

Mr. Albert Ladd Colby, consulting engineer, New York, has returned from a trip to Europe, after more than a year's absence. During this time Mr. Colby studied different types of by-product coke ovens, recovery processes and testing of American coal in by-product ovens. He will open an office in this city in the near future.

Mr. Arthur T. Doud, who has recently been associated with The Walker M. Levett Co., New York, in the capacity of Manager, has accepted a position with J. G. White and Co., as Cost Engineer.

Mr. Orman B. Humphrey, Consulting Engineer, Bangor, Maine, who for the past year has been engaged on the preliminary engineering in connection with the Ryegate Light & Power Company's hydro-electric development on Wells River, Vermont, has completed his work, and active construction has begun.

Mr. Alfred R. Kipp, formerly with The Arnold Company, Chicago, Ill., has accepted a position with the Wisconsin Central Railway as Superintendent of Motive Power and Cars.

Mr. J. E. Stuntz, formerly Chief Engineer and Superintendent, Calle Aguiar 81, Havana, Cuba, has accepted a position with the Cape Cruz Co., Ensenada de Mora, Cuba, in the capacity of Chief Chemist.

Mr. Sidney Withington, who has been associated with Harvard University as Assistant in engineering, has entered the service of the Walworth Manufacturing Co.

NECROLOGY

FREDERIC A. C. PERRINE

On October 20, 1908, Frederic Auten Combs Perrine died at his home in Plainfield, New Jersey, thus bringing to an end a life of usefulness hardly more than well begun.

Dr. Perrine was born at Manalapan, New Jersey, August 25, 1862. He was prepared for college at the Freehold Institute, New Jersey, and entered Princeton University in 1879. He received from that institution the degree of A.B. in 1883 and remained as a post-graduate until 1885, when the degree of Sc.D. was conferred upon him, and he was nominated one of the honor men of that year. In 1886 Princeton conferred upon him the further degree of A.M.

The habit of study, acquired at college, lasted until shortly before his death, his interests constantly broadening. He specialized very early in electrical engineering and on leaving college associated himself with the United States Electric Lighting Company of New York, one of the first electric manufacturing and operating companies in this country. Dr. Perrine early developed an interest in matters other than engineering, and for many years devoted considerable time to University settlement and other sociological work, his active interest relaxing only when his professional duties became too exacting.

In 1889 he became associated with John A. Roebling's Sons Company as manager of the insulated wire department, retaining this position until 1892, during which time he undertook a great deal of investigation and research, with a view to placing the manufacture of insulated wire upon a scientific basis. He published the well-known "Roebling Handbook," which has since gone through many revisions and editions, but which, at the time of its first publication, was practically the only comprehensive handbook of the character in this country.

His investigations while in the wire business developed an interest in conducting materials which lasted until his death, and resulted in the publication of his book on "Conductors for Electrical Distribution" in 1903.

In 1892 he became associated with the Germania Electric Company of Boston as treasurer and manager. His connection with this company was brief, which was probably fortunate as it left him free to enter into his happiest and most successful work—that of teaching. In 1893 he was appointed Professor of Electrical Engineering at Stanford University in California. Prior to this time he served as judge and member of several important committees of the World's Fair at Chicago.

At the time of Dr. Perrine's appointment at Stanford University, the electrical-engineering department had not been organized. He installed a course which successfully combined the study of the physics and mathematics of electricity and its application to engineering, holding a balance between the theoretical and practical education.

Dr. Perrine's success as a teacher, however, was principally due to his personality and intimate contact with his men, and to his association with them outside of the lecture room and laboratory.

During the latter part of his incumbency of the chair of electrical engineering at Stanford University, he held the position of chief engineer of the Standard Electric Company of California (now a part of the system of the Pacific Gas and Electric Company), where his work included the electrical design of the system, which was the first long-distance 60-kilovolt transmission plant to be undertaken. He was awarded a gold medal at the Paris Exposition in 1900 for this work.

In 1900 he became president and general manager of the Stanley Electric Manufacturing Company of Pittsfield, Mass., a position which he occupied until 1904, when he took up private practice as a consulting engineer in New York, which he maintained until his death.

He was a contributor to technical literature, and with Geo. P. Low was editor of the "Journal of Electricity" from its inception in 1894 until 1896, during which time his communications, under the caption of "Passing Comment," were critical commentaries on the technical affairs and developments of the times. From 1896 to 1898 he was an editor of "Electrical Engineering," published in Chicago. He presented many papers before technical societies, educational institutions and other public bodies.

He was a member of the American Institute of Electrical Engineers, serving on many important committees; of the Institution of Electrical Engineers (London); the American Society of Civil Engineers; The National Electric Light Association, and other technical and learned societies.

On June 28, 1893, he was married to Margaret, daughter of Ferdinand W. Roebling, who, with three children, survives him.

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Alphabetical Index to Advertisers Page 24
Classified List of Advertisers Pages 21 to 23

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Whiton Machine Co., D. E., New London, Conn.

CLUTCHES, FRICTION.

Dodge Mfg. Co., Mishawaka, Ind.

COMPRESSORS, AIR.

Riverside Engine Co., Oil City, Pa.

COMPRESSORS, GAS.

Riverside Engine Co., Oil City, Pa.

CONVEYORS, AUTOMATIC.

Link Belt Co., Philadelphia, Pa.
Dodge Mfg. Co., Mishawaka, Ind.

COPPER CONVERTING MACHINERY.

Alliance Machine Co., Alliance, O.

COUNTERBORES.

Morse Twist Drill & Machine Co., New Bedford, Mass.

COUNTERSHAFTS.

Builders Iron Foundry, Providence, R. I.

COUPLING, SHAFT.

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CRANES.

Alliance Machine Co., Alliance, O.
Cleveland Crane & Car Co., Wickliffe, O.
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Whiting Foundry Equipment Co., Harvey, Ill.

CUPOLAS, FOUNDRY.

Whiting Foundry Equipment Co., Harvey, Ill.

CUTTERS, MILLING.

Morse Twist Drill & Machine Co., New Bedford, Mass.

DRILLS.

Morse Twist Drill & Machine Co., New Bedford, Mass.

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General Electric Co., Schenectady, N. Y.
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ELECTRICAL MACHINERY.

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General Electric Co., Schenectady, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.

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Struthers-Wells Co., Warren, Pa.
Wisconsin Engine Co., Corliss, Wis.

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American Engine Co., Bound Brook, N. J.
Buckeye Engine Co., Salem, O.
Hooven, Owens & Rentschler Co., Hamilton, O.
Morris Machine Works, Baldwinsville, N. Y.
Murray Iron Works Co., Burlington, Iowa.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
St. Louis Iron & Machine Works, St. Louis, Mo.
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Wisconsin Engine Co., Corliss, Wis.

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American Gas Furnace Co., New York.

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Whiting Foundry Equipment Co., Harvey, Ill.

FURNACES, ANNEALING AND TEMPERING.

American Gas Furnace Co., New York.

FURNACES.

Whiting Foundry Equipment Co., Harvey, Ill.

FURNACES, GAS.

American Gas Furnace Co., New York.

GAS GENERATORS.

American Gas Furnace Co., New York.

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American-Goetze-Gasket & Packing Co., New York.

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American Goetze-Gasket & Packing Co., New York.

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Struthers-Wells Co., Warren, Pa.

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Golden-Anderson Valve Specialty Co., Pittsburg, Pa.

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Whiton Machine Co., D. E., New London Conn.

GEARS.

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HANGERS, SHAFT.

Dodge Mfg. Co., Mishawaka, Ind.

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Seneca Falls Mfg. Co., Seneca Falls, N. Y.

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General Electric Co., Schenectady, N. Y.
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Dodge Mfg. Co., Mishawaka, Ind.

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PUMPS, GAS DRIVEN.

Riverside Engine Co., Oil City, Pa.

PUMPS, TRIPLEX.

Sandusky Foundry & Machine Co., Sandusky, O.

PUNCHES AND SHEARS.

Alliance Machine Co., Alliance, O.

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Morse Twist Drill & Machine Co., New Bedford, Mass.

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Golden-Anderson Valve Specialty Co., Pittsburg, Pa.

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RIVETERS, HYDRAULIC.

Alliance Machine Co., Alliance, O.

ROLLING MILL MACHINERY.

Alliance Machine Co., Alliance, O.

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SMOKELESS FURNACE.

Detroit Stoker & Foundry Co., Detroit, Mich.

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Detroit Stoker & Foundry Co., Detroit, Mich.

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Morse Twist Drill & Machine Co., New Bedford, Mass.

TRACK, INDUSTRIAL.

Whiting Foundry Equipment Co., Harvey, Ill.

TRAPS, STEAM.

Albany Steam Trap Co., Albany, N. Y.
Davis Co., John, Chicago, Ill.
Golden-Anderson Valve Specialty Co., Pittsburg, Pa.

TRANSMISSION MACHINERY.

Dodge Mfg. Co., Mishawaka, Ind.
Link Belt Co., Philadelphia, Pa.

TURBINES, STEAM.

Hoover, Owens & Rentschler Co., Hamilton, O.

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National Machinery Co., Tiffin, O.

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Golden-Anderson Valve Specialty Co., Pittsburg, Pa.

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Davis Co., John, Chicago, Ill.
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VALVES, BOILER STOP.

Golden-Anderson Valve Specialty Co., Pittsburg, Pa.

VALVES, BLOW-OFF.

Golden-Anderson Valve Specialty Co., Pittsburg, Pa.
Davis Co., John, Chicago, Ill.

VALVES, CHECK.

Albany Steam Trap Co., Albany, N. Y.
Davis Co., John, Chicago, Ill.
Golden-Anderson Valve Specialty Co., Pittsburg, Pa.
Nelson Valve Co., Philadelphia, Pa.
Walch & Wyeth, Chicago, Ill.

VALVES, FLOAT.

Golden-Anderson Valve Specialty Co., Pittsburg, Pa.

VALVES, GATE.

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Albany Steam Trap Co., Albany, N. Y.
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Golden-Anderson Valve Specialty Co., Pittsburg, Pa.
Walch & Wyeth, Chicago, Ill.

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Davis Co., John, Chicago, Ill.

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Davis Co., John, Chicago, Ill.
Nelson Valve Co., Philadelphia, Pa.

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Davis Co., John, Chicago, Ill.

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Dodge Mfg. Co., Mishawaka, Ind.

WIRE NAIL MACHINES.

National Machinery Co., Tiffin, O.

WOOD POLISHING WHEELS.

Builders Iron Foundry, Providence R. I.

WOODWORKING MACHINERY.

Seneca Falls Mfg. Co., Seneca Falls, N. Y.

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ALPHABETICAL LIST OF ADVERTISERS

Advertising Supplement to the Journal of
The American Society of Mechanical Engineers

Machine Shop Equipment

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Classified List of Advertisers Pages 21 to 23

HARTNESS FLAT TURRET LATHE

OUR RECORD

1855—We made the first turret machine having mechanism for automatically turning the turret.

1858—We produced the present form of high turret with substantially the turret-turning mechanism now in universal use.

1870—One of the links in the chain of evolution, showing an automatic chuck.

1882—The first clutch back-geared machine.

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1891—The first Flat Turret Lathe.

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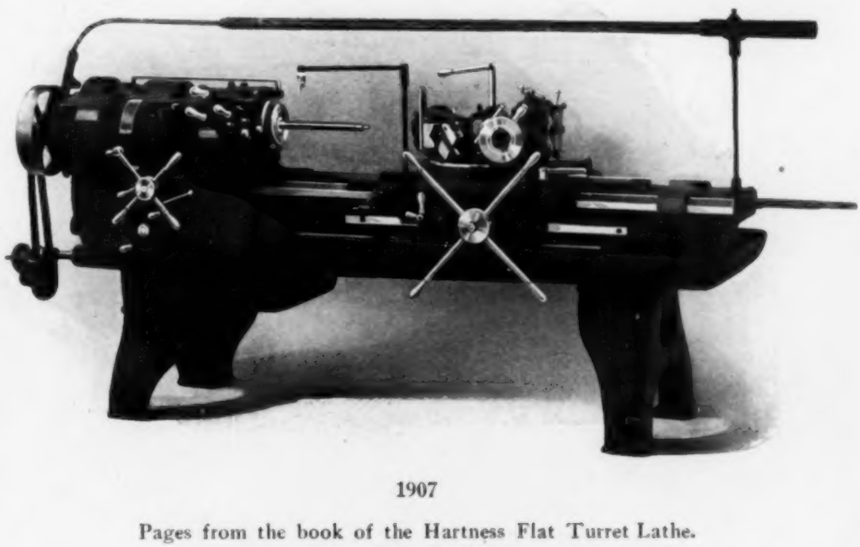

1907

Pages from the book of the Hartness Flat Turret Lathe.
Copies of book cheerfully mailed on request.

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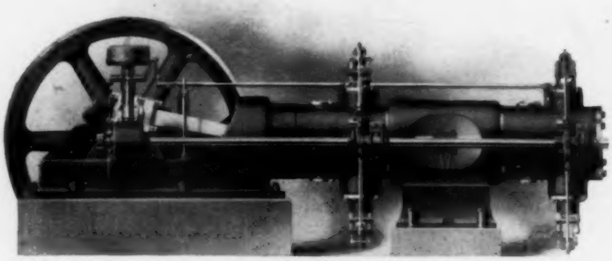
Power Plant Equipment

ALPHABETICAL INDEX TO ADVERTISERS PAGE 24
CLASSIFIED LIST OF ADVERTISERS PAGES 21 TO 23

The Buckeye Four-Stroke Cycle
GAS ENGINE
SINGLE and DOUBLE ACTING



In powers from 50 to 6000 Horses

Catalogs on Application — Free from Complications

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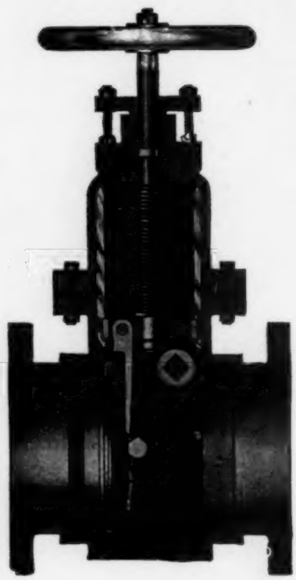
The Erwood Swing Gate Valve



as a *Safety* Non-Return on Condenser and Heater Connections.

The Valve is KEPT CLOSED at all times by means of a spring of light tension, the Swing Gate opening at each impulse of the engine; but SHOULD THE VACUUM BE LOST, OR THE CONDENSER OR THE HEATER BECOME FLOODED, THE WATER CANNOT BACK UP THROUGH THE ERWOOD VALVE INTO THE CYLINDER.

Flooded Condensers or Flooded Heaters are no longer a menace if the Erwood Valve be used.

Walch & Wyeth,
87 Lake St. Chicago

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BLOWERS, POSITIVE PRESSURE.

American Gas Furnace Co., New York.

BLOW PIPES AND BLOWERS.

American Gas Furnace Co., New York.

BLUE PRINTING MACHINE.

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Robb-Mumford Boiler Co., S. Framingham, Mass.

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Manning, Maxwell & Moore, New York.

BOLT AND NUT MACHINERY.

Manning, Maxwell & Moore, New York.
National Machinery Co., Tiffin, O.

CAR HAULS, WIRE CABLE.

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CARS, SCALE.

Alliance Machine Co., Alliance, O.

CASE HARDENING MACHINES.

American Gas Furnace Co., New York.

CASTINGS, SPECIAL HEAVY.

Hooven, Owens & Rentschler Co., Hamilton, O.

CENTERING MACHINES.

Whiton Machine Co., D. E., New London, Conn.

CHUCKS, DRILL.

Morse Twist Drill & Machine Co., New Bedford, Mass.
Whiton Machine Co., D. E., New London. Conn.

CHUCKS, LATHE.

Whiton Machine Co., D. E., New London, Conn.

CLUTCHES, FRICTION.

Dodge Mfg. Co., Mishawaka, Ind.

COAL CUTTERS.

Jeffrey Mfg. Co., Columbus, O.

COMPRESSORS, AIR.

Riverside Engine Co., Oil City, Pa.

COMPRESSORS, GAS.

Riverside Engine Co., Oil City, Pa.

CONVEYORS, AUTOMATIC.

Link Belt Co., Philadelphia, Pa.
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Jeffrey Mfg. Co., Columbus, O.

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Builders Iron Foundry, Providence, R. I.
Dodge Mfg. Co., Mishawaka, Ind.

COUPLING, SHAFT.

Dodge Mfg. Co., Mishawaka, Ind.

CRANES.

Alliance Machine Co., Alliance, O.
Cleveland Crane & Car Co., Wickliffe, O.
Manning, Maxwell & Moore, New York.
Whiting Foundry Equipment Co., Harvey, Ill.

CUPOLAS, FOUNDRY.

Whiting Foundry Equipment Co., Harvey, Ill.

CUTTERS, MILLING.

Morse Twist Drill & Machine Co., New Bedford, Mass.

DRILLS.

Manning, Maxwell & Moore, New York.
Morse Twist Drill & Machine Co., New Bedford, Mass.

DRAFTSMAN'S SQUARE.

Kelsey, D. J., New Haven, Conn.

DYNAMOS.

General Electric Co., Schenectady, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.

ELECTRICAL MACHINERY.

American Engine Co., Bound Brook, N. J.
General Electric Co., Schenectady, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.

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Jeffrey Mfg. Co., Columbus, O.
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Link Belt Co., Philadelphia, Pa.

ENGINES, GAS.

Buckeye Engine Co., Salem, O.
Riverside Engine Co., Oil City, Pa.
Struthers-Wells Co., Warren, Pa.
Wisconsin Engine Co., Corliss, Wis.

ENGINES, STEAM.

American Engine Co., Bound Brook, N. J.
Buckeye Engine Co., Salem, O.
Hooven, Owens & Rentschler Co., Hamilton, O.
Morris Machine Works, Baldwinsville, N. Y.
Murray Iron Works Co., Burlington, Iowa.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
St. Louis Iron & Machine Works, St. Louis, Mo.
Struthers-Wells Co., Warren, Pa.
Wisconsin Engine Co., Corliss, Wis.

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American Swiss File and Tool Co., New York.
Reichhelm & Co., E. P., New York.

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Whiting Foundry Equipment Co., Harvey, Ill.

FURNACES, ANNEALING AND TEMPERING.

American Gas Furnace Co., New York.

FURNACES.

Whiting Foundry Equipment Co., Harvey, Ill.

FURNACES, GAS.

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American Gas Furnace Co., New York.

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American Goetze-Gasket & Packing Co., New York.

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Manning, Maxwell & Moore, New York.
Whiton Machine Co., D. E., New London, Conn.

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Morse Twist Drill & Machine Co., New Bedford, Mass.

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Alliance Machine Co., Alliance, O.
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HANGERS, SHAFT.

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LATHES, TURRET.
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Seneca Falls Mfg. Co., Seneca Falls, N. Y.

LATHES, ENGINE.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

LATHES, WOOD.
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Dodge Mfg. Co., Mishawaka, Ind.

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PUMPS, GAS DRIVEN.
Riverside Engine Co., Oil City, Pa.

PUMPS, TRIPLEX.
Sandusky Foundry & Machine Co., Sandusky, O.

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Alliance Machine Co., Alliance, O.

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Whiting Foundry Equipment Co., Harvey, Ill.

TRAPS, STEAM.

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Davis Co., John, Chicago, Ill.
Golden-Anderson Valve Specialty Co., Pittsburg, Pa.

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Dodge Mfg. Co., Mishawaka, Ind.
Link Belt Co., Philadelphia, Pa.

TURBINES, STEAM.

Hoover, Owens & Rentschler Co., Hamilton, O.

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National Machinery Co., Tiffin, O.

VALVE DISCS, METALLIC.

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VALVES, AUTOMATIC.

Golden-Anderson Valve Specialty Co., Pittsburg, Pa.

VALVES, BACK PRESSURE.

Davis Co., John, Chicago, Ill.
Walch & Wyeth, Chicago, Ill.

VALVES, BOILER STOP.

Golden-Anderson Valve Specialty Co., Pittsburg, Pa.

VALVES, BLOW-OFF.

Golden-Anderson Valve Specialty Co., Pittsburg, Pa.
Davis Co., John, Chicago, Ill.
Manning, Maxwell & Moore, New York.

VALVES, CHECK.

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Manning, Maxwell & Moore, New York.
Nelson Valve Co., Philadelphia, Pa.
Walch & Wyeth, Chicago, Ill.

VALVES, FLOAT.

Golden-Anderson Valve Specialty Co., Pittsburg, Pa.

VALVES, GATE.

Albany Steam Trap Co., Albany, N. Y.
Nelson Valve Co., Philadelphia, Pa.
Walch & Wyeth, Chicago, Ill.

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VALVES, HYDRAULIC.

Nelson Valve Co., Philadelphia, Pa.

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Golden-Anderson Valve Specialty Co., Pittsburg, Pa.
Walch & Wyeth, Chicago, Ill.

VALVES, RADIATOR.

Detroit Lubricator Co., Detroit, Mich.

VALVES, REDUCING.

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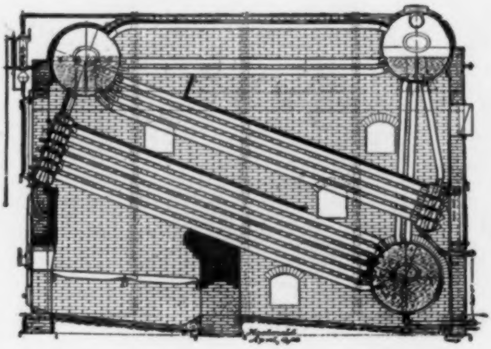

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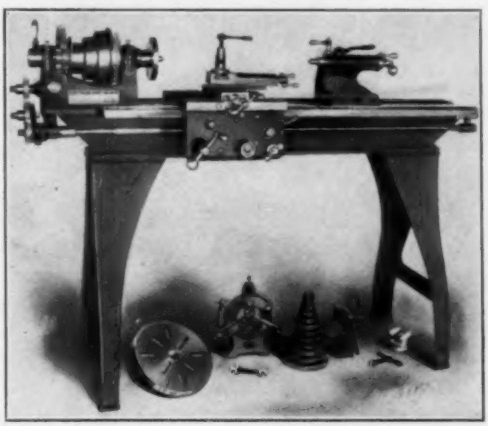

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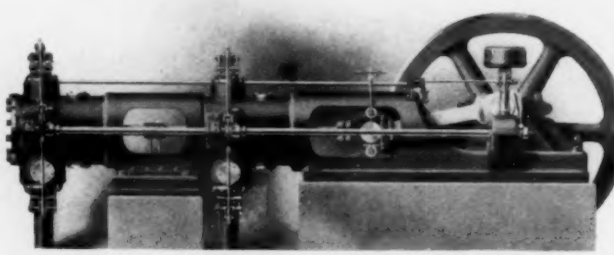

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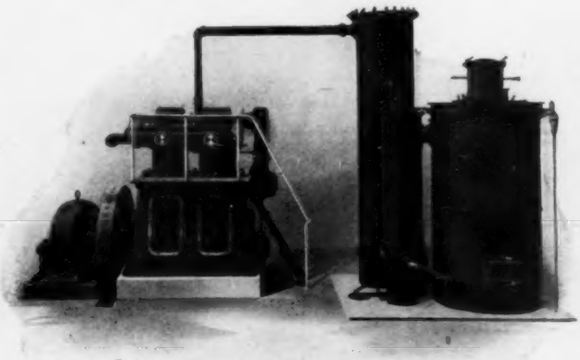

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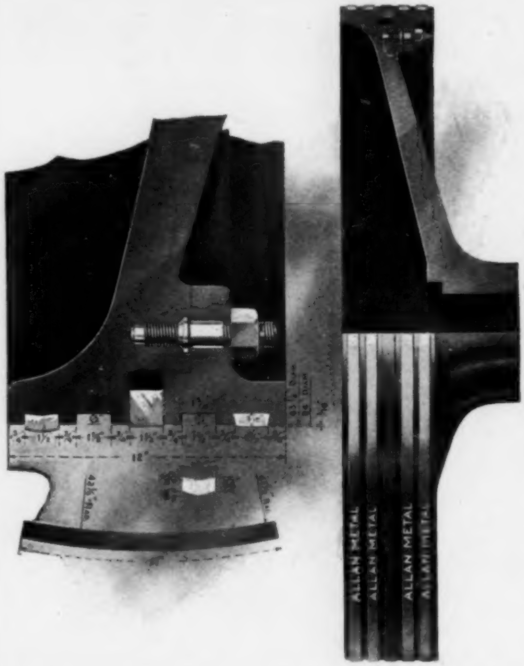

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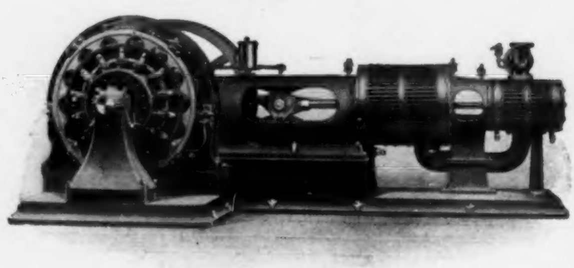

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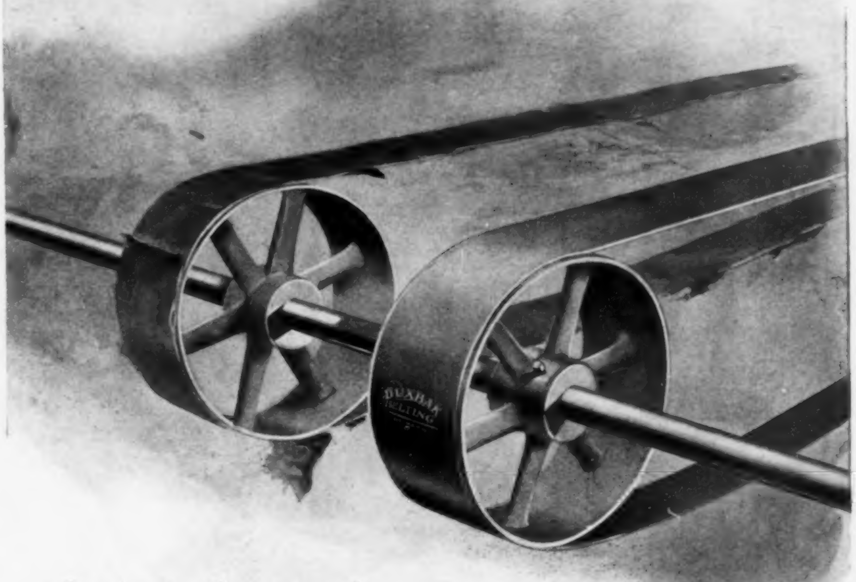

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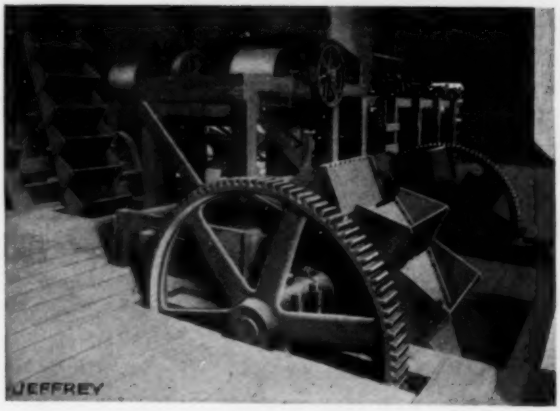

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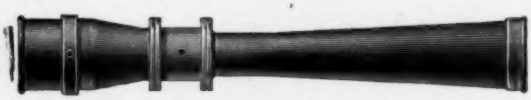

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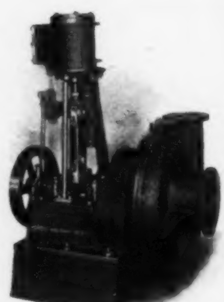

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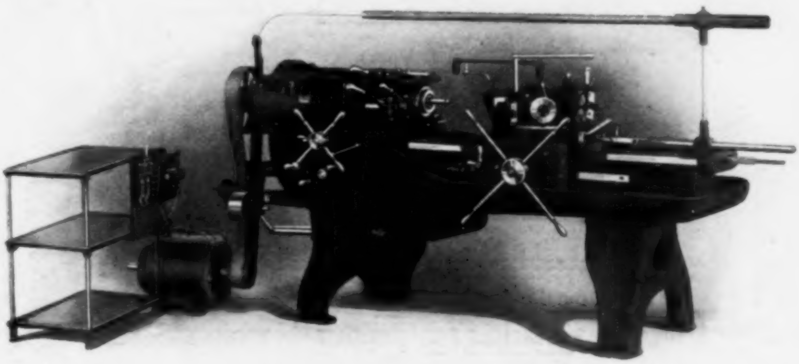

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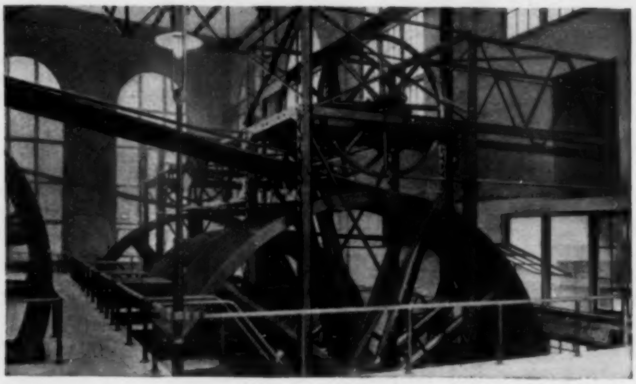

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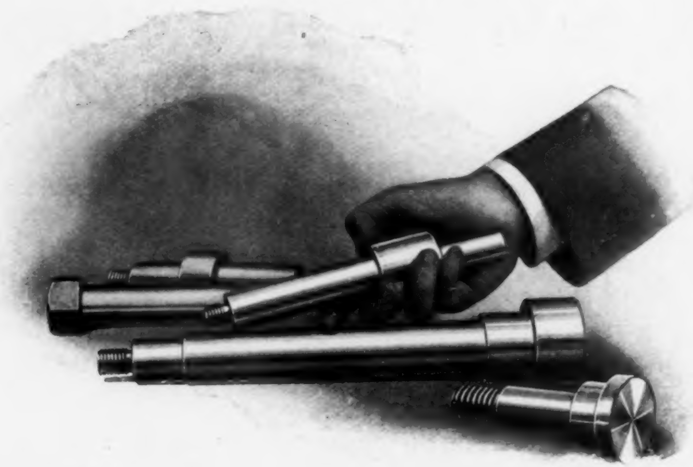
HARTNESS FLAT TURRET LATHE

Working Range for Bar Work

THE work shown on this page is the product of the 2 x 24-inch Flat Turret Lathe with the automatic die outfit (outfit D). This outfit gives the highest efficiency on such work. It turns all diameters up to 2¼ inches, and all lengths up to 24 inches, and cuts all U. S. standard screws from ⅜ to 1¼ inches, inclusive, by sixteenths. (Whitworth, Metric or V standard furnished if desired.) Items of outfits on pages 86 and 87.

The same kind of work is turned out by the 3 x 36-inch with automatic die outfit; turning diameters from 3 inches down, and lengths up to 36 inches, and cutting screw threads from 1 to 2 inches, inclusive, U. S. standard. (Whitworth, Metric or V standard furnished if desired.) Items of outfits on pages 88 and 89.



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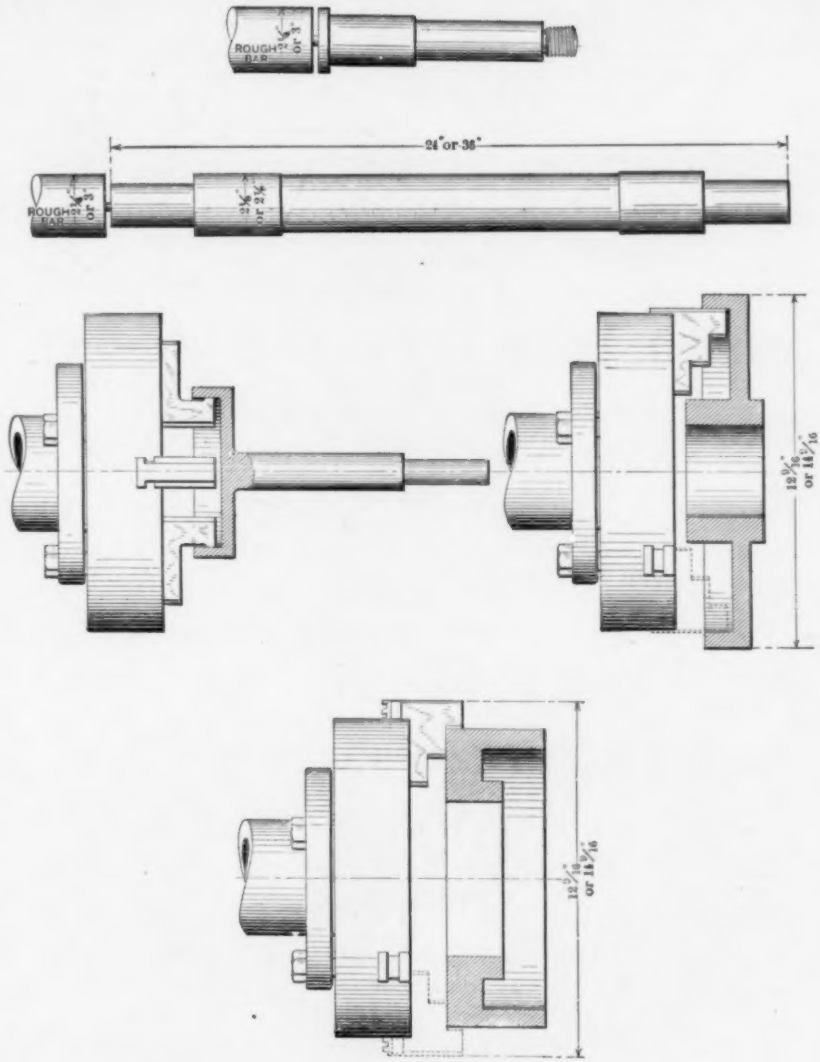

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Le Génie Civil. *Weekly*. Paris. Jan. to July 1898. Vol. 32.

Institution of Naval Architects. London. Transactions. Vol. 15, 1874.

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Power. *Monthly*. New York. Vols. 1-6, 1879-1885

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Scientific American. *Weekly*. First Series. Vols. 1 and 2, 1845-1846.

Sibley Journal of Engineering, Sibley College, Cornell University. Vol. 12, 1897-1898.

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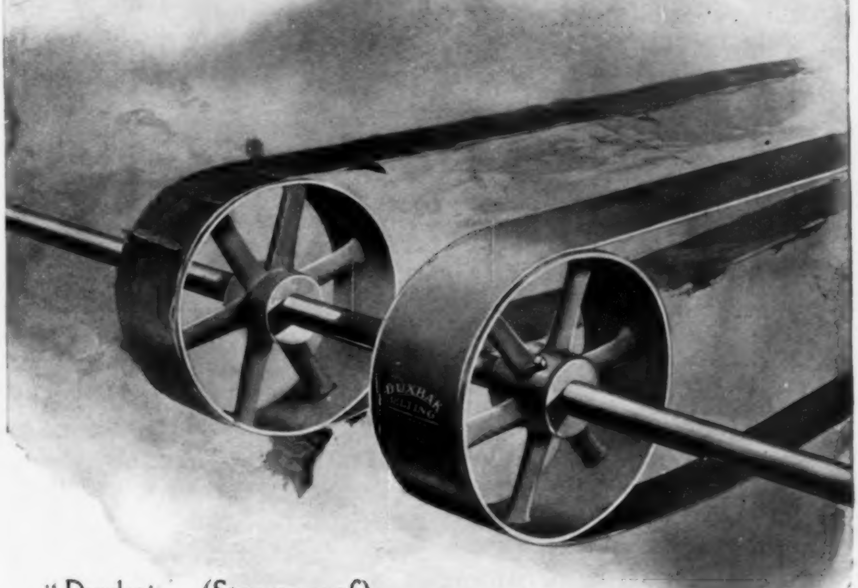
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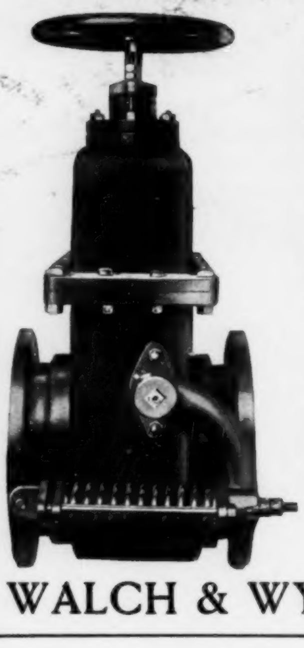

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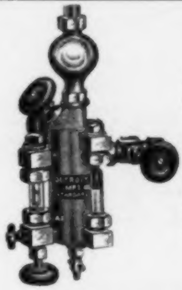

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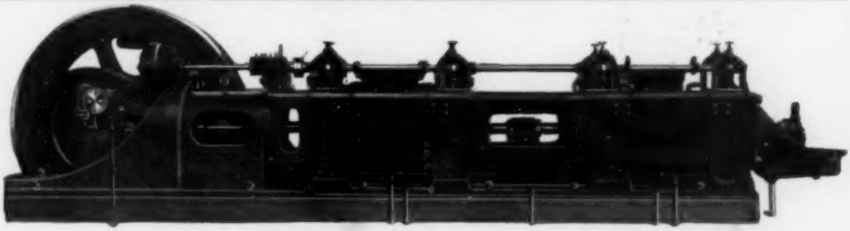

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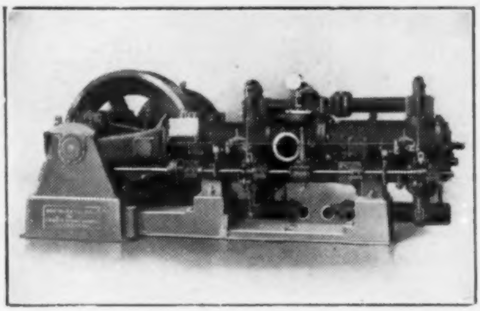

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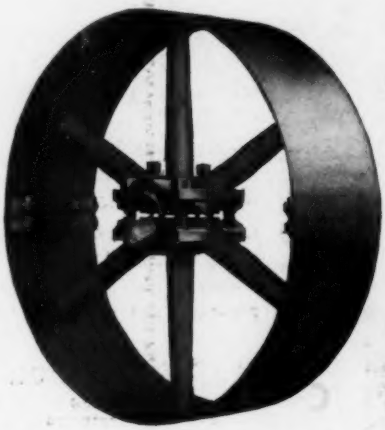

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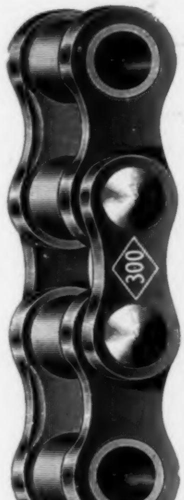

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